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BLACKIE'S SCIENCE TEXT-BOOKS

AN ELEMENTARY TEXT-BOOK OF ANATOMY

BY

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PREFACE.

Text-Books on Anatomy have in later years grown to such dimensions as to be fitted only for study by those who are able to devote two or more years to acquiring a knowledge of that science. An attempt has been made in the following pages to give such a view of Anatomy as may serve as an introduction to Junior Students of medicine, and may give to women training—for the practical work of nursing the sick—all the information of the structure of the body they need. To others, not professed students, who may desire simply to obtain an exact but elementary knowledge of the structure of their own bodies, this little work may perhaps be more inviting and serviceable than a treatise of greater elaboration and bulk.

The illustrations have been drawn from various sources, and are duly acknowledged. A large number are taken from Dr. J. M'Gregor-Robertson's *Elementary Text-Book of Physiology*, belonging to the same series of Science Text-Books as the present volume. By arrangement with Messrs. J. & A. Churchill, very many illustrations have been borrowed from Wilson's *Anatomist's Vade-Mecum.* The writer, having several times edited that work, has necessarily been unable to avoid slight resemblances to it here and there in the present work, which is nevertheless strictly original

in the sense of having been written from the knowledge gained by the author during more than twenty years' experience as a teacher of anatomy.

24 India Street, Glasgow,
January, 1895.

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ELEMENTARY ANATOMY.

Anatomy is the knowledge of the structure of organized bodies, and in its literal sense the term includes the study of the structure both of plants and animals. It has, however, in general usage, come to be applied especially to the knowledge of the construction of the bodies of men and animals, obtained by dissection. In the following pages we shall limit our view to the anatomy of the human subject, excepting where a more striking illustration of a fact described can be obtained in another animal than man.

Human Anatomy, or *Anthropotomy*, is most conveniently divided into the following sections:—

Histology,	...	The description of the tissues.			
Osteology,	...	,,	,,	,,	bones.
Arthrology,	...	,,	,,	,,	joints.
Myology,	..	,,	,,	,,	muscles.
Angeiology,	...	,,	,,	,,	vessels.
Neurology,	...	,,	,,	,,	nervous system.
Splanchnology,	...	,,	,,	,,	internal organs.

HISTOLOGY.

THE DESCRIPTION OF THE TISSUES.

Histology is the description of the elementary tissues of the body. Some of these are distributed throughout the body, and are found in every tissue and in every organ; others are limited to particular organs. Some are simple in their constitution, others are complex. The tissues which will be

described in this section of the work are the following:—Cells, blood and lymph corpuscles, epithelium, areolar tissue, fibrous tissue, fat, cartilage, bone, muscle, nerve, blood-vessels, lymphatic vessels and glands, serous and synovial membranes, mucous membrane, secreting glands.

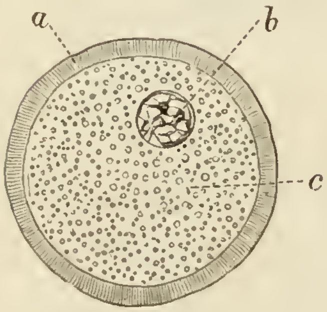


Fig. 1.—Diagrammatic Representation of Ovum.

a, Zona pellucida, or limiting membrane; *b*, nucleus with nucleoli; *c*, protoplasm of cell with numerous granules and fatty globules. [From Klein.]

Cells and Protoplasm.—In its early condition the body consists entirely of minute solid particles called *cells*. Some of these retain the same form throughout their whole life, but the larger number undergo changes which result in the production of the various tissues found throughout the body. In the latter case the original cellular character is evidenced by the persistence of small remains of the cells, called *nuclei*, in the fully-formed tissues.

A **cell** consists of a substance which has been named **Protoplasm**, in which there is embedded a round spot, the *nucleus*. Within the latter there may often be seen a smaller spot, the *nucleolus*. Protoplasm is a translucent substance, having much the consistence of white-currant jelly; it has the power of appropriating nutrient material, of dividing and subdividing so as to form new masses like unto itself, and when not formed into a tissue, it has the power of changing its shape and of moving from place to place by means of delicate processes it puts out. Every tissue of the human body is formed through the agency of protoplasm, although in most cases the transformation the latter undergoes is so great that little evidence remains of its existence.

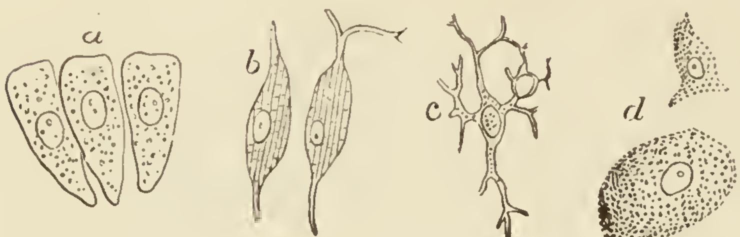


Fig. 2.—Various forms of Cells.

a, Columnar cells found lining various parts of the bowel (called *columnar epithelium*); *b*, cells of a fusiform or spindle shape found in the loose tissue under the skin and in other parts (called *connective tissue cells*); *c*, cell having many processes or projections—such are found in connective tissue—may contain pigment; *d*, primitive cells composed of protoplasm with nucleus, and having no cell-wall. All are represented about 400 times their real size. [Robertson.]

Cells may be defined as *nucleated masses of protoplasm.* Vegetable cells have generally a bounding membrane, or *cell-wall*, but those of animal tissue are seldom so distinguished. Cells when free are usually round or oval, but when packed together become fusiform, hexagonal, or scale-like; in certain tissues

Fig. 3.—A Drop of Blood, seen under a Microscope magnified by 350 diameters. (Robertson.)

a, Red corpuscle, seen on its edge; *b*, red corpuscle, seen on the flat; *c*, white corpuscle.

they are branched, and the branches of neighbouring cells join together.

Blood.—Blood is rather a thick fluid, of a bright red or scarlet colour in the arteries, and of a purple tint in the veins. It has a salt taste, an alkaline reaction, and a peculiar faint odour.

It consists of a transparent fluid, the *liquor sanguinis*, and of solid bodies, the *corpuscles*, floating in the fluid. When drawn from the body it speedily solidifies or *coagulates* into a jelly-like substance, called a *clot*, which contracts and squeezes out a little straw-coloured fluid, the *serum*. In the process of clotting a substance called *fibrin* is formed. The relation

between the constituents of fluid blood and coagulated blood is shown in the following table:—

Liquid blood	Corpuscles . . .		Clot	Coagulated blood.
	Liq. sanguinis	Fibrin		
		Serum . . .		

The blood corpuscles are of two kinds, *red* and *white*, the proportion of the two being on an average 1 white to 500 red. A cubic millimetre of healthy blood contains 5,000,000 red corpuscles and 10,000 white corpuscles.

The **red corpuscles** are circular biconcave discs, measuring about $\frac{1}{3200}$ of an inch in width and $\frac{1}{12000}$ of an inch in thickness, and being devoid of a nucleus.

The **white corpuscles** are larger than the red ones, and measure about $\frac{1}{2500}$ of an inch. When at rest they are spherical, and have a granular appearance, but they have the power of changing their shape, and of moving from place to place by putting out processes of their substance. They are transparent masses of protoplasm, each with one or more nuclei, and have no cell-wall.

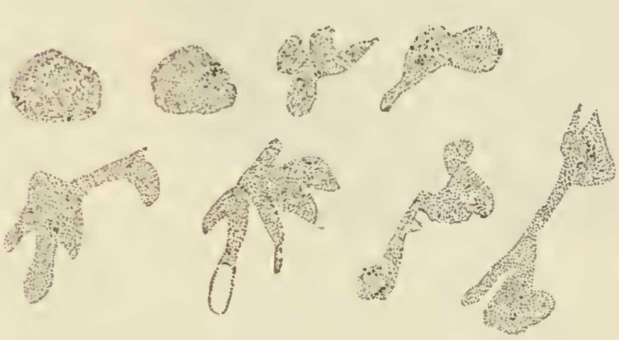


Fig. 4.—White Blood Corpuscle. Its successive changes of shape. [Klein.]

Other smaller corpuscles have in recent years been described; they are called *hæmatoblasts* or *blood-platelets*, but little is known of their nature or uses.

The **liquor sanguinis** or fluid of the blood is composed of the serum and of two factors which by their union form **fibrin.**

Serum consists of the salts of the blood, fatty matter, albumen, water, gases, and sugar.

The **gases of the blood** are the following:—Oxygen, for the most part carried by the red corpuscles; carbonic acid, in com-

bination with the salts of the serum; nitrogen, suspended in the liquor sanguinis.

Lymph and Chyle.—Lymph is the fluid contained in a system of vessels distinct from the blood-vessels, and called lymphatics or absorbents. Lymph consists of a clear fluid, the *lymph-plasma*, with solid particles, the *lymph-corpuscles*, floating in it. The plasma is like the liquor sanguinis of the blood, but contains less albumen and salts. The corpuscles are indistinguishable from the white corpuscles of the blood.

Chyle is the fluid contained in the lymphatics of the intestines during digestion. It is milky in appearance, owing to suspended fatty matters, the products of digestion, and it contains corpuscles identical with those of lymph.

Fig. 5.—Flattened Scale-like Cells of *squamous epithelium* from the lining membrane of the human mouth. [Klein.]

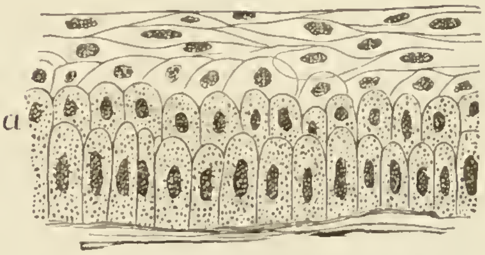


Fig. 6.—Stratified Squamous Epithelium. [Klein.]

Both lymph and chyle resemble blood in spontaneously coagulating when removed from the body.

Epithelium.—This is one of the very few tissues which retain the cellular character throughout the whole of life. Epithelium is chiefly used for the purpose of protection; thus it forms the superficial layers of the skin, covers the mucous membrane of the intestinal, genito-urinary, and respiratory tracts, and lines the ducts of glands. A single layer of similar cells forms the serous membranes lining the cavities of the abdomen, thorax, cranium, and spinal canal, and paves the interior of the heart, blood-vessels, and lymphatics; such cells are often nowadays described under a separate title as *endothelium*.

Epithelium may occur in a single layer of cells or in many layers, hence for convenience of description all epithelia are divided into *simple non-stratified* and *stratified*.

The varieties of epithelium are the following:—

1. Squamous.
2. Columnar.
3. Glandular.
4. Transitional.
5. Ciliated

Squamous epithelium (tesselated epithelium) consists of flattened scales, which are very thin in proportion to their size; they may have a small nucleus in the centre, but often are quite devoid of one. When the nucleus has disappeared they become mere horny plates, which are easily detached. Such cells are found forming the surface layer of the skin, the lining of the mouth and lower part of the nostrils, the surface of the cornea of the eye.

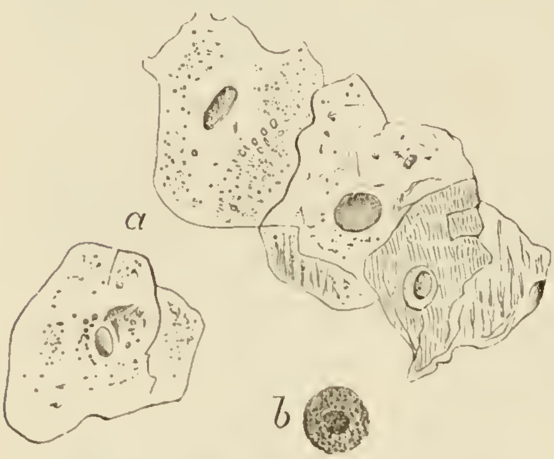


Fig. 7.—*b*, Spheroidal Cell from Salivary Gland, with *a*, Squamous Cells from the mouth. [Robertson.]

Columnar epithelium consists of pear-shaped or elongated cells, having their broad ends directed to the free surface of the membrane on which they are placed. They may form the superficial layer of stratified cells, but more frequently exist as a single layer of cells on the surface of a mucous membrane; in this form they are found lining the stomach and intestines.

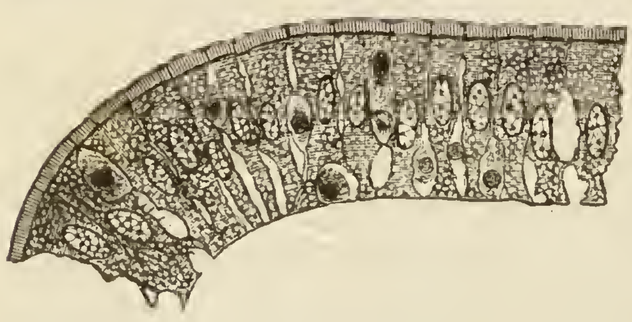


Fig. 8.—Columnar Epithelial Cells from the small bowel. [Schäfer.]

Spheroidal or **glandular epithelium** is composed of round cells, or of such as (having been round) have become angular by mutual pressure. It forms the lining of glands, such as the liver, pancreas, intestinal glands, glands of the skin.

Transitional epithelium is the early form of the several varieties of epithelium; it generally consists of small granular round cells.

Ciliated epithelium is distinguished by the presence of very minute hair-like processes or *cilia*, which grow out from the free end of the cell, and are in perpetual motion as long as the cell is alive. This motion is always in the same direction, and serves to carry away secretions and even foreign particles in contact with the membrane on which the cells are placed, to the outlet where they may be discharged. Ciliated epithelium is especially plentiful in the air passages, where it is of use in keeping a free passage for the entrance and exit of air; it is also found in the uterus (womb), the ducts of certain glands, the testicles, Fallopian tubes, and the cavity of the middle ear.

Fig. 9.—Cells of Ciliated Epithelium.

Connective Tissue.—This is the material which serves to unite and bind together the different organs and tissues. It consists of fibres and cells, the former largely preponderating, varying greatly in arrangement and in the proportion of different kinds of fibres in different organs and tissues.

Three varieties are usually described:—

Areolar. Fibrous. Elastic.

Areolar tissue consists of delicate fibres crossing each other and inextricably intermixed, so as to form irregular meshes or *areolæ;* these are occupied by a small quantity of fluid, sufficient to keep the fibres moist. In the midst of the fibres are branched protoplasmic cells, the *connective tissue corpuscles.* The fibres are of two kinds, *white* or *inelastic* and *yellow* or *elastic*, the former being greatly in excess in most cases. Areolar tissue is found beneath the skin, beneath serous and mucous membranes, between and around muscles, supporting the essential tissues of organs and glands, around nerves and blood-vessels.

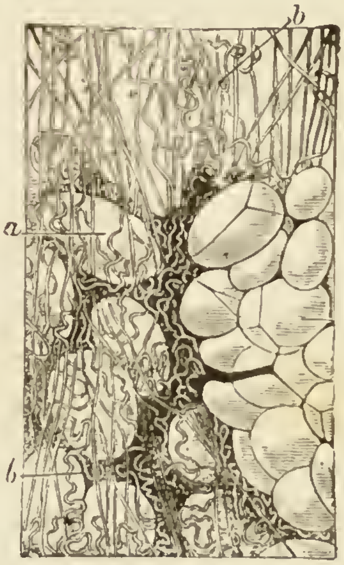


Fig. 10.—Areolar and Adipose Tissue.

a, a, Fat vesicles; *b, b,* fibres of areolar tissue. [Wilson.]

Adipose tissue is an important variety of areolar tissue; in it the areolæ or interspaces are occupied by little vesicles containing oil. Adipose tissue (commonly known as fat) is especially plentiful beneath the skin, in the abdominal cavity, on the surface of the heart, round the kidneys, and in the marrow of bones.

Fibrous tissue.—This tissue is formed of the white fibres spoken of above as constituting the major part of areolar tissue. When these fibres are acted on by acetic acid, they swell up and become transparent. Between the fibres protoplasmic masses (the connective tissue corpuscles) are found. The fibres may be so woven as to form a sheet, as in the periosteum of bone, the fasciæ around muscles, and the capsules of organs; or they may be aggregated into bundles and form rope-like bands, as in the ligaments of joints and the tendons of muscles. In the latter form the fibres are almost exclusively of the white variety, but in the former there is a slight admixture of yellow elastic fibres.

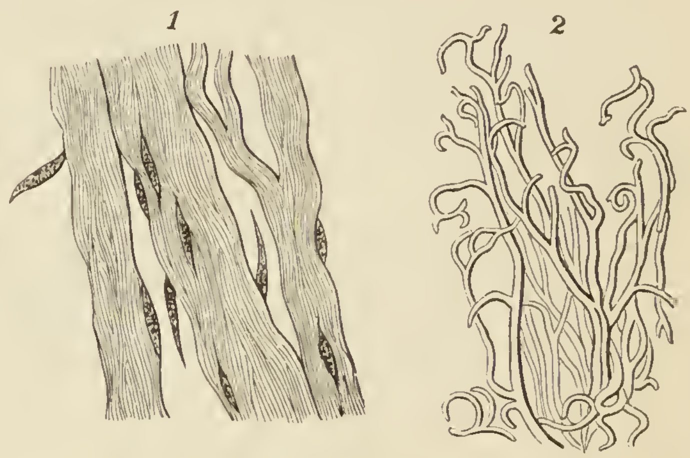


Fig. 11.—Fibres of (1) White Fibrous, and (2) Yellow Elastic Tissue.

Yellow fibrous or **elastic tissue** is found mixed with white fibres in areolar tissue, in fasciæ, ligaments, the skin, and the coats of blood-vessels. It is found almost pure in the ligaments which join the laminæ of the vertebræ together, in the true vocal cords, and in certain ligaments of the voice-box (larynx). The fibres are larger than those of white fibrous tissue, they are of a faint yellow tinge, their ends curl up when the fibres are cut, and they are unaffected by acetic acid.

Cartilage.—Cartilage or gristle is a tough but highly-elastic substance, having a bluish-white opalescent appearance, and being so soft as to be easily cut with a knife. It consists of a *matrix* or ground substance in which *nucleated cells* are imbedded, either singly or in groups. The matrix has not

always the same characters; sometimes it has a fine ground-glass appearance, when the cartilage is spoken of as a *hyaline cartilage*; in other instances the matrix is pervaded or replaced by white fibrous tissue, constituting a *white fibro-cartilage*; or, again, there is between the cells a mesh-work of yellow elastic fibres, and this form is called *reticular* or *yellow fibro-cartilage.* In hyaline cartilage the cells occupy spaces in the matrix, and are surrounded by a capsule; one cell may occupy a space, or there may be two, three, four, or more; in the latter case they become modified in shape by mutual pressure, and bear evidences of having been formed from a single cell. This kind of cartilage forms the early state of the great majority of the bones (*temporary cartilage*), but it is also found as a permanent tissue, coating the articular ends of long bones (*articular cartilage*) and forming the cartilages which connect the ends of the ribs with the breast-bone (*costal cartilages*). White fibro-cartilage is found forming the discs between the bodies of the vertebræ, as pads in the interior of the knee, wrist, and some other joints (*inter-articular fibro-cartilages*), deepening the cavities of ball-and-socket joints, and forming grooves for tendons to play in. *Yellow fibro-cartilage* forms the expanded part of the ear, the lid of the air-tube (the epiglottis) and certain other parts of the voice-box, and the Eustachian tube connecting the middle ear and the throat.

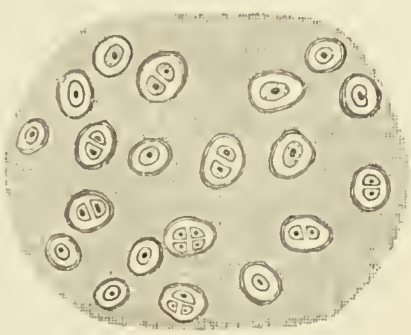


Fig. 12.—Hyaline Cartilage, as seen magnified.

Bone.—Bone is composed of earthy matter (chiefly in the form of lime salts) and of animal matter, in the proportion of about two-thirds of the former to one-third of the latter. The earthy matter may be entirely removed by prolonged steeping in dilute hydrochloric acid (1 to 5 of water), when the bone will become soft and flexible, but will still retain its former shape. In like manner the animal matter may be taken out by burning the bone, until only the mineral matter remains, when (as before) no change will be made in the shape, but the bone will become white and ash-like, and will crumble easily

in the fingers. The composition of bone is shown in the following table:—

Animal matter -	Gelatin, fat, and blood-vessels,		33·6
Earthy matter -	Phosphate of lime,	51·04	
	Carbonate of lime,	12·80	
	Fluoride of lime,	1·50	
	Phosphate of magnesia,	1·00	
	Chloride of soda, &c.,	0·06	
			66·4
			100·0

In children the animal matter is in larger proportion, and hence the bones often bend instead of breaking. In old age, on the other hand, they are more brittle because there is a reduction in the proportion of animal matter.

Structure of Bone.—If a long bone be sawn down the centre, it will be found that the shaft is a hollow cylinder formed of very dense, hard bone, and having in the interior a cavity, the *medullary canal*, filled with soft, yellow fat, the *medulla* or *marrow*. At the ends, where the bone expands, there is no medullary cavity, and the bony tissue is spongy, with only a very thin layer of dense bone on the outside. The spongy bone is formed by a beautiful spider-web-like lattice-work of bony threads, the meshes of which are filled with red marrow. The spaces or meshes are called *cancelli*, and bone of this kind is described as *cancellous tissue.* The exterior of the bone is in the fresh state covered by a membrane called the *periosteum*, which consists of fibrous tissue, supporting a large number of blood-vessels and some nerves passing to the bone. On the surface next the bone there are (if the bone be young) a great number of protoplasmic masses (cells), through the agency of which the bone grows. On the wall of the medullary canal, similar cells and blood-vessels are found, but there is, as a

Fig. 13.—Showing dense bone outside, spongy bone within.

rule, no true membrane formed (the *endosteum* of former writers). Everywhere over the surface of the bone there are small pores leading into the substance, but these are more numerous near the ends of the bones. One of them is especially large and constant in each bone; it is called the *nutrient foramen*, and transmits the *nutrient artery*. In a microscopic section of the bone (either longitudinal or transverse) it is found that these pores communicate with minute canals which traverse the bone, and are called the *Haversian canals*. A transverse

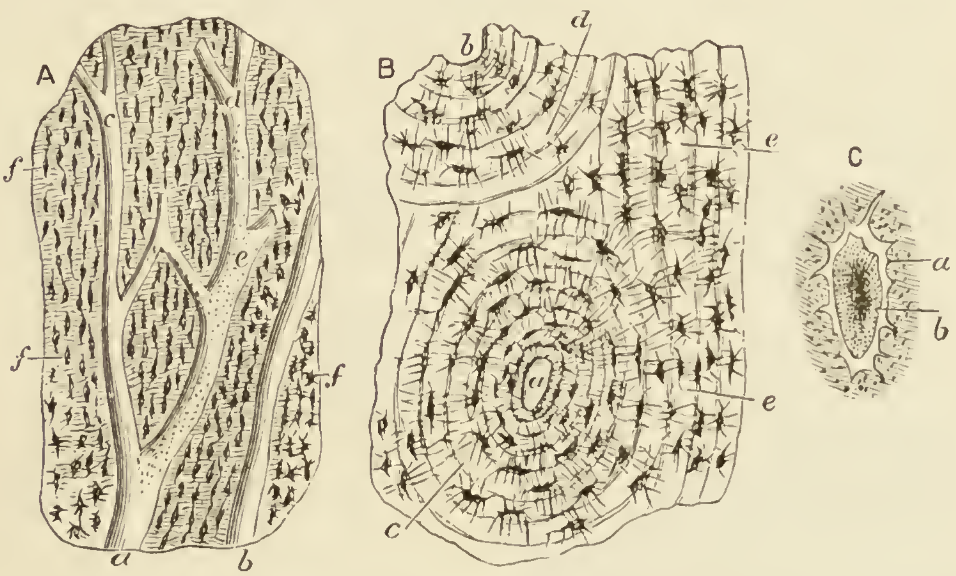


Fig. 14.—Microscopical appearance, A, of longitudinal section of bone, and B, of transverse section. C, A bone cell, highly magnified, lying in lacuna.

section, such as that given in fig. 14, B, shows that each canal is surrounded by concentric rings of bone substance, the *Haversian laminæ* (*c*), and that these have in them irregular black bodies, communicating with each other by fine irregular lines. The black bodies are really little cavities, *lacunæ* (little lakes) (A, *f*), and the lines passing from one to the other are fine canals, *canaliculi*. The Haversian canals carry the blood-vessels throughout the bone, but also contain protoplasmic cells, nerve-fibres, and lymphatic vessels. The lacunæ are occupied by protoplasmic masses, called *bone cells*, fig. 14, C, and fine filamentous continuations of these pass into the canaliculi. These arrangements are all designed for the supply of nutrient material to the bone, and for the carrying on of the physiological activity of the tissue.

With few exceptions, all bones are originally laid down in cartilage, which subsequently gets converted into bone. In the case of the long bones, the extremities are developed from separate bony growths from those forming the shafts of the bones, and remain separate from the shaft till the growth of the bone is completed. These centres of ossification are called *epiphyses.* They are necessary in order to allow of growth taking place without any interference with the integrity of the joints. In children an accident may cause the separation of one of these epiphyses, and this may (if

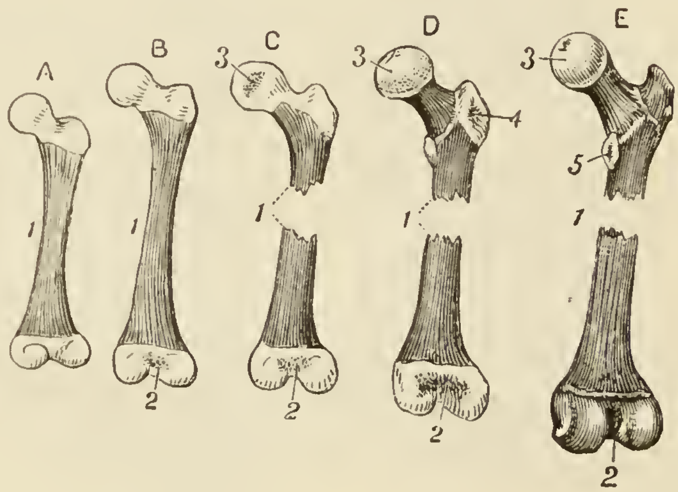


Fig. 15.—Centres of Ossification of the Thigh-bone.

A, The bone of the fœtus; B, at the time of birth; C, at about a year old; D, at the 5th year; E, at 15 years. 1, Centre for the shaft; 2, for the lower extremity; 3, for the head; 4, for the great trochanter; 5, for the lesser trochanter.

unrecognized) seriously impair the growth of the bone. Bones grow in length by new bone being formed at the end of the shaft next the epiphysis, and in thickness by new bone being formed beneath the periosteum.

The flat bones of the skull have certain peculiarities. They are formed of an outer and an inner "table" of dense bone, with loose spongy bone, called *diplöe*, between, traversed by a large number of veins which freely intercommunicate. The dense layers have no Haversian canals.

Muscle.—Muscles are the organs by which locomotion is effected; they form the mass of the flesh of the body, and it is found that in a person weighing 150 lbs. the muscles represent about 62 lbs., or more than two-fifths of the whole.

The muscles are most numerous and largest in the limbs, and so completely surround the bones as, in most cases, to conceal the greater portion of them. In the trunk some of

them are spread out to enclose cavities; in this way they form the abdominal wall, contribute to the formation of the wall of the chest, and serve to separate the cavities of the chest and abdomen (diaphragm).

Structure of Muscle.—Most of the muscles of the body are of a deep red colour, but in the walls of the intestines, bladder, blood-vessels, and many other places, pale muscular fibres are alone found. Thus we can divide all muscles into *red* and *white*. But there are other differences besides colour between these two forms, for the red are under the control of the will, and hence are called *voluntary* muscles, while the white are distinguished as *involuntary* muscles. Further, the former differ from the latter in certain particulars of structure which lead us to speak of the voluntary as *striated muscle*, and the involuntary as *non-striated muscle.*

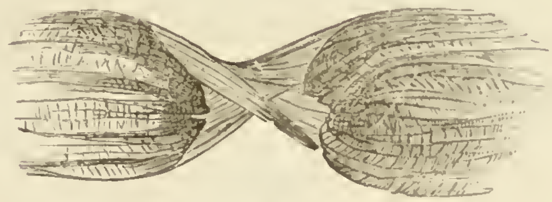


Fig. 16.—A Striped Muscular Fibre with its Sheath.

Structure of Voluntary Muscle.—Every muscle is made up of an aggregation of *fibres* gathered into prismoid bundles, the *fasciculi.* Each fibre is contained in a delicate, transparent sheath, the *sarcolemma*, which is so fine that it is only made visible when the fibre is ruptured, as shown in fig. 16. The fibre may split up longitudinally into finer fibres, the *fibrillæ*, and transversely into *discs.* When examined under a high microscopic power each fibre is seen to be marked by alternate light and dark stripes, and these markings form the characteristic feature of voluntary muscle, by which it may, under all circumstances, be recognized. Across

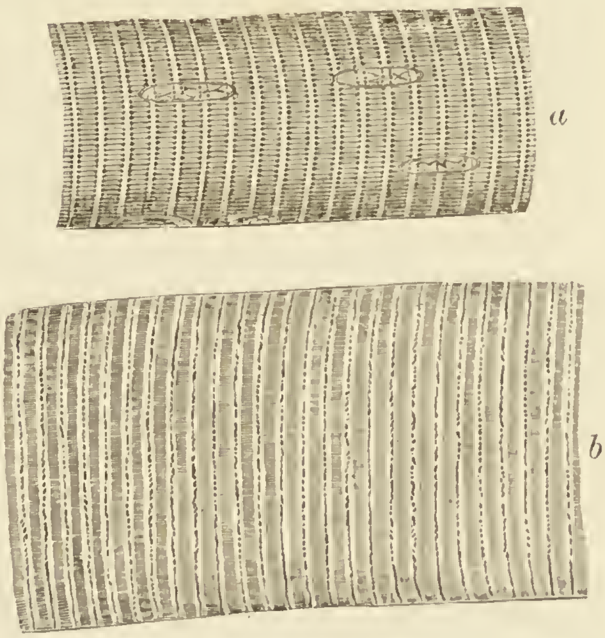


Fig. 17.—Muscular Fibre, *a* showing nuclei, and *b* the dark lines in the light band.

the light stripe a very faint secondary dark stripe may be made out (fig. 17). Various explanations of the cause of the transverse striation have from time to time been propounded, but none has hitherto met with general acceptance. Beneath the sarcolemma, on the surface of the muscular fibre, numerous fine *nuclei* are found, the remains of the protoplasm from which the fibre was formed (fig. 17*a*).

Structure of Involuntary Muscle.—Non-striated, plain, or involuntary muscular fibres consist of elongated, fusiform cells, pointed at each end, and having in the centre a rod-shaped nucleus. They are united by an adhesive substance into fasciculi, which are generally flattened, pale in colour, and never of any great thickness. Unstriped muscle takes part in the formation of the wall of the alimentary canal, from the middle of the gullet to the anus. It is found in the excretory ducts of various glands, the walls of the arteries, veins, and lymphatic vessels, the windpipe and bronchial tubes, the gall bladder and common bile duct, the spleen, testicle, womb, urinary bladder, ureters, the eye, and skin.

Fig. 18.—A Spindle Cell of Involuntary Muscle, highly magnified.

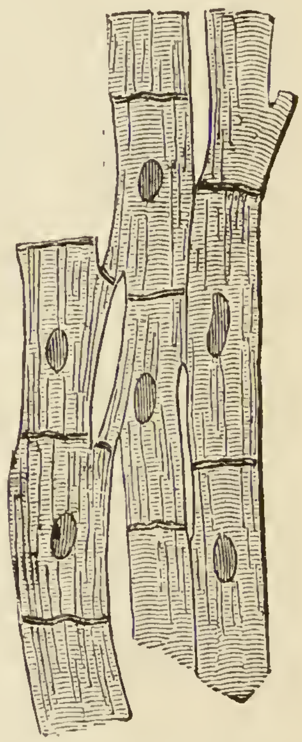


Fig. 19.—Involuntary Striated Muscle of Heart.

The **muscular fibre of the heart** is peculiar. Although involuntary in its action it is transversely striated, and is therefore a solitary example of *striated involuntary muscle.* The fibres have no sarcolemma; they branch and communicate with each other, and are formed of quadrate cells with a large oval nucleus in the centre of each.

Nervous Tissue.—The nervous system consists of the **nerve centres** and of fine cords or **nerves**, by means of which the centres are connected with each other, and with the various organs and tissues of the body. The **nerve tissues** are dis-

tinguishable as **nerve-fibres** and **nerve-cells**. The former are the elements found chiefly in the nerves, and the latter in the centres.

Nerve-fibres.—These are minute cords, having a transparent appearance during life, but becoming opaque after death. When stained with colouring agents each fibre is found to consist of a central rod, the **axis-cylinder**, surrounded by a white fatty substance, the **white matter of Schwann** or **medullary sheath**, and enclosed in a delicate sheath, the **neurilemma**. From the axis-cylinder being thus separated from the neurilemma by the medullary sheath, the cylinder looks like a pith or marrow, and hence such were named **medullated** or **white nerve-fibres**. Here and there along the course of the fibres the medullary sheath is interrupted, but the axis-cylinder is continued across the gap. These breaks are known as the **nodes of Ranvier**. **Nuclei** are found at wide intervals beneath the neurilemma. In the nerve centres, and throughout the sympathetic system of nerves, there is no medullary sheath in the nerve-fibres, the axis-cylinder being in direct contact with the neurilemma—such are spoken of as **gray** or **non-medullated nerve-fibres**.

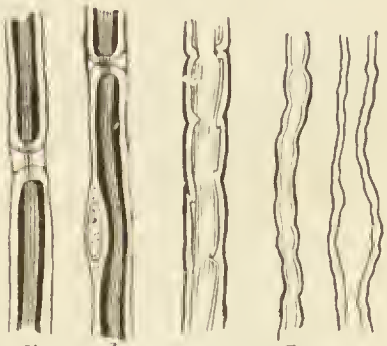


Fig. 20.—Nerve-fibres.

a and *b*, Medullated nerve-fibres: both show a node of Ranvier, but *b* shows also a nucleus beneath the neurilemma; *c* and *d* give the appearance of nerves after death; *e*, a non-medullated nerve-fibre.

Nerve-cells.—These vary greatly in size and shape: some measure only $\frac{1}{6000}$ of an inch, and others as much as $\frac{1}{200}$. The most characteristic feature of the majority of them is that they possess processes or "**poles**", by means of which they become connected with each other and with the axis-cylinder of nerves entering or leaving the nerve centre. Some have only one pole, and are then said to be **unipolar**, others have two or three, and are called **bi-** or **tri-polar**, and those that have more than three are named **multipolar** cells. The protoplasm of the cells is often granular, and of a light-brown or grayish colour, and sometimes contains brown pigment. The cells of

the surface of the brain are triangular or pyramidal in shape, and always have the base of the pyramid directed towards the centre of the brain (fig. 21 *f*). Those of the spinal cord are generally large and multipolar the branches given off from them being numerous and complicated (see fig. 21 *a* and *e*).

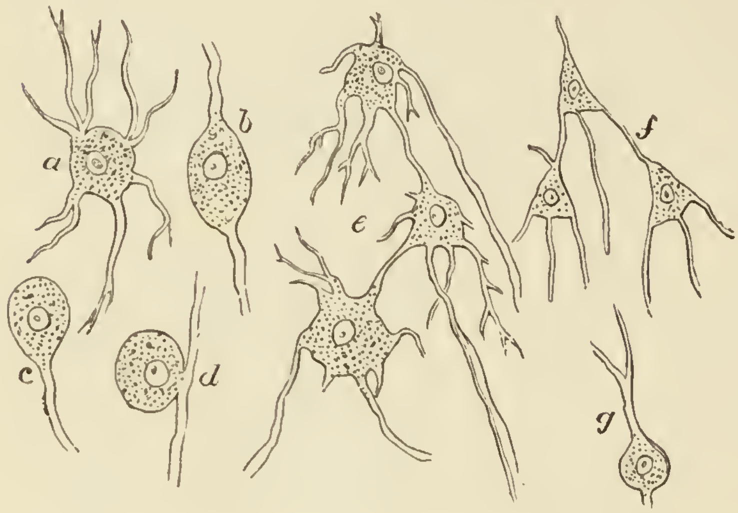


Fig. 21.—Various Forms of Nerve-cells.

a and *e* from the spinal marrow; *b* and *d* from ganglia on posterior roots of spinal nerves; *c* and *g* from the lesser brain (cerebellum); *f* from the cortex of the great brain (cerebrum).

The nerve tissues of the brain and spinal cord are supported by a peculiar modification of connective tissue called **neuroglia.**

Aggregations of nerve-cells constitute **nerve-centres.**

Ganglia are small aggregations of nerve-cells found in various parts of the body, having nerve-fibres connected with them, and forming small nerve centres.

A **nerve** is a rounded or flattened cord of nerve-fibres, forming the means of communication between the centres and the parts of the body connected with them. The nerve-fibres are gathered into bundles or **funiculi,** and these are put together to form nerves, and are surrounded by a sheath of fibrous tissue, the **nerve-sheath.**

A **plexus** is an intricate intercommunication between the bundles of a nerve.

The **apparent origin** of a nerve is where it becomes connected with the surface of a nerve centre; the **real origin** is the part where the fibres terminate in the cells of the gray matter.

Blood-vessels.—The blood is distributed throughout the body by means of fine tubes, which, starting from the heart, pass to all the organs and tissues, and return to the heart again; thus the blood constantly returns to the centre from

which it set out, and this constitutes the **circulation**. The vessels performing this work are of three kinds: the arteries, carrying the blood from the heart to the tissues; the capillaries, which convey it through the tissues; and the veins, carrying it back to the heart.

Structure of Arteries.—Arteries are so called because, from their being found empty after death, they were supposed by the ancients to carry air (αὴρ τηρεῖν, to contain air). They communicate with each other, such communications being called **inosculations** or **anastomoses**; these becoming more frequent as the vessels decrease in size, and are consequently more liable to blocking or interruption by pressure. An artery has three coats. The **outer** (*adventitia*) is strong and thick; it consists of fibrous tissue, with a slight admixture of elastic fibres. The **middle coat** (*media*) consists of many layers of unstriped muscular tissue with, in the larger arteries, the addition of elastic tissue and a small quantity of white fibrous tissue. The **inner coat** (*intima*) is the thinnest and most brittle of the three; it is formed of an inner lining of a single layer of flattened cells, and outside this of elastic tissue.

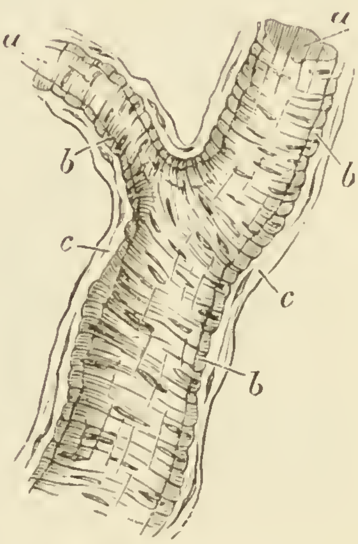


Fig. 22.—Structure of an Artery.

a, Inner coat; *b*, middle coat; *c*, outer coat.

The large vessels are of a yellowish tinge, in consequence of the elastic tissue being the predominant element. The small arteries are of a deeper and redder colour because the muscular tissue is most pronounced; their contractility being necessary to regulate the supply of blood going to any part.

Structure of Capillaries.—These are very fine tubes running through the several tissues and organs. Their walls are formed of fine flattened cells, joined edge to edge by a cement substance, which becomes stained brown when pencilled with a nitrate of silver solution. The cells are nucleated, and the nuclei frequently cause a bulging of the wall at the points where they are situated. Capillaries vary in size,

but average $\frac{1}{3000}$th of an inch in diameter. They differ greatly in their arrangement in the different tissues, but the disposition is constant for each tissue, so that it is possible from the capillary arrangement alone to distinguish the tissue under the microscope.

Fig. 23.—The Structure of Capillaries.

a, Medium-sized capillary; *b* and *d*, small capillaries, showing nuclei of cells, *c*.

Structure of Veins.—Veins have the same three coats as arteries, but they are so thin that veins collapse when cut, whereas arteries remain open. Veins are much more numerous than arteries, and a very large number are placed just beneath the skin, whereas arteries are for the most part placed deeply. Veins are also distinguished by the possession of delicate valves, which are so arranged as to prevent the blood returning from the heart towards the tissues, but allow of its passing freely towards that organ. The valves are most numerous in the veins of the limbs, and especially those of the leg; there are no valves in very small veins, or in those of the brain, liver, kidney, and womb; and they are also absent from very large veins, as the vena cava, innominate, pulmonary, and iliac veins.

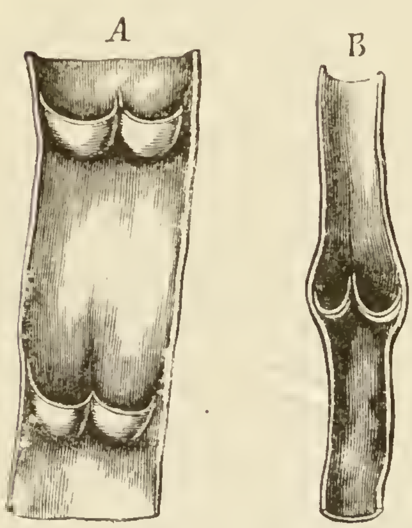


Fig. 24.—A, Part of a vein laid open, with two pairs of valves; B, Longitudinal section of a vein showing the valves closed. [Wilson.]

Sinuses are venous channels excavated in the structure of an organ, and lined by the inner coat of the veins. The most important sinuses are those of the brain and of the uterus.

Arteries and veins receive small twigs of nerves from the sympathetic system (*vaso-motor nerves*).

Lymphatics.—**Lymphatic Vessels** form a secondary vascular system, and serve to carry the products of digestion into

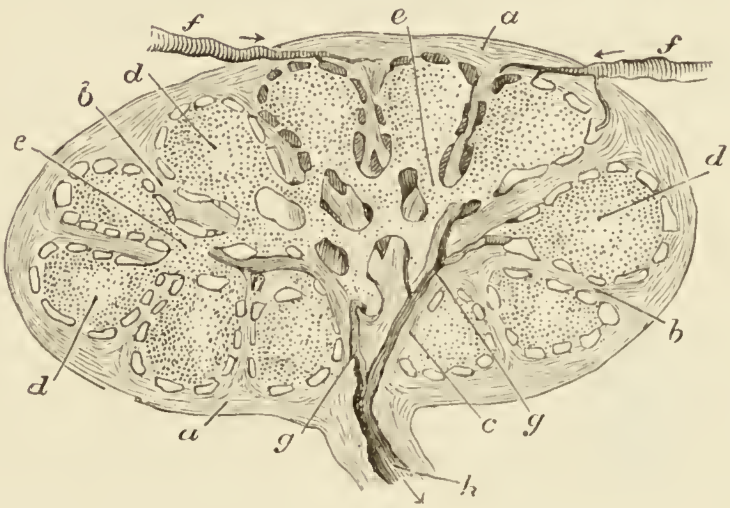
the blood, and also to return to that fluid materials which, although once used, are capable of being used again, and do not require to be excreted. Those which carry the products of digestion are called **lacteals**; when digestion is not going on they carry clear fluid (lymph) like the other lymphatics; and there is no structural difference between them.

The lymphatic system consists of three parts—**vessels, capillaries,** and **glands.**

Lymphatic Vessels much resemble veins, but they are smaller, are colourless, and have a larger number of valves.

Fig. 25.—The Structure of a Lymphatic Gland.

a, Capsule; *b*, fibrous strands passing into gland; *c*, similar strands in centre; *d*, lymph nodules; *e*, nodules of different spaces communicating; *f*, lymph vessels entering gland; *g*, *h*, lymph vessel leaving gland.



They have three coats, and the valves are formed by the inner coat.

Lymphatic Capillaries are chiefly remarkable for their irregularity, and for their extensive distribution throughout the tissues and organs of the body.

Lymphatic Glands (called also **Absorbent Glands**) are found in largest number in the mesentery, the membrane which fixes the intestines to the posterior wall of the abdomen. They are distributed throughout the neck, arm-pit, groin, back of knee, thorax, and back of abdominal cavity. The gland is inclosed in a firm capsule formed of fibrous tissue, from which strands of fibres pass into the centre and divide it into irregular spaces. Those in the outer part (cortex) are of considerable size and oval in shape, while those in the centre (medulla) are much smaller, and are irregular. The spaces are occupied by **adenoid tissue**, a variety of connective tissue formed by a net-

work of branched cells, the meshes of which are packed with round cells of various sizes. The adenoid tissue does not completely fill the spaces, channels being left between the outer surfaces of the tissue-masses and the walls of the spaces, along which the lymph travels, these forming the *lymph-path.* On the outside of the gland numerous small lymphatic vessels pierce the capsule and enter the cortex (fig. 25, *f, f*), to end in the lymph-path, while one or two larger vessels leave the medulla (fig. 25, *g, h*), the former carry the lymph (or chyle) to the gland, and the latter carry it away. They communicate freely with each other by means of the lymph-path.

Lymphatic glands are plentifully supplied with blood by small arteries, and with sympathetic twigs of nerves.

Serous Membranes.—These occur as thin transparent membranes lining the interior of the cavities containing the viscera, and are so arranged as to permit of the movement of the viscera with a minimum of friction. They are the pleura, which envelopes the lungs; the pericardium, which surrounds the heart; the peritoneum, which invests the viscera of the abdomen; the arachnoid in the spinal canal and cranial cavity, and the tunica vaginalis in front of the testicle. A serous membrane is usually described as forming two layers, the one enveloping the viscus (*visceral*) and the other lining the wall of the cavity (*parietal*), but it will be seen by looking at fig. 26 that it is really one continuous layer which covers both. All serous membranes form shut sacs, with the exception of the peritoneum in the female, where there is a communication with the cavity of the womb by means of the Fallopian tubes.

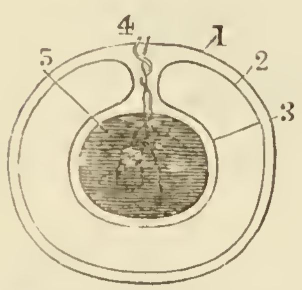


Fig. 26.—Plan of a Serous Membrane.

1, Wall of cavity; 2, parietal layer of serous membrane; 3, visceral layer; 4, vessel entering the reflection; 5, the contained organ. [Wilson.]

In **structure** the serous membrane consists of a single layer of flattened cells, supported by a connective tissue basis in which blood-vessels are distributed. In health it only secretes sufficient fluid to lubricate and keep soft and smooth the opposing surfaces.

Synovial Membranes.—These are almost identical in structure with serous membranes, but the secretion is thicker, and more like white of egg. Besides lining the cavities of joints, they also form closed sacs, which are interposed between tendons and bones to diminish friction in their movements. Three classes of synovial membranes are described, namely, those lining the cavities of joints (**articular**), those forming closed sacs (**bursal**), and those forming lubricating sheaths for tendons (**ensheathing**).

Synovial membranes are entirely formed of connective tissue, but on the surface the tissue corpuscles become flattened and crowded together so as to produce an appearance similar to that of the cells lining the serous membranes. The synovial membranes of joints only pass a little way over the edge of the articular cartilages, and do not cover their whole surface.

Mucous Membrane.—This is the tissue which lines those internal passages of the body communicating with the exterior. It secretes a viscid fluid, called **mucus**, for the protection and lubrication of its surface. There are two great tracts of mucous membrane, the **gastro-pulmonary** and **genito-urinary**; the former includes the membrane lining the air-passages and the intestinal tract, the latter that of the kidneys, urinary bladder, and genital organs.

In **structure**, mucous membrane consists of a deep layer, composed of connective tissue, in which vessels and nerves divide and are distributed. Above this is an exceedingly thin membrane, formed by cell-plates placed edge to edge (**basement membrane**), and on this one or more layers of epithelium, in which no vessels are found. In the intestinal canal the epithelium is in a single layer of columnar cells; in the windpipe it is in many layers, and the surface cells are ciliated. Mucous membrane has generally many glands opening on to its surface, but these will be described along with the anatomy of the several organs of which this membrane forms a part.

Secreting Glands.—All secreting glands consist essentially of a **basement membrane**, on one side of which are secreting cells, and on the other side a plentiful supply of blood

contained in capillary vessels. Some glands are very simple, and are nothing but short tubes lined by cells, and supplied with blood-vessels on their deep aspect. Others are so complicated as to be difficult to unravel. For the purpose of descrip-

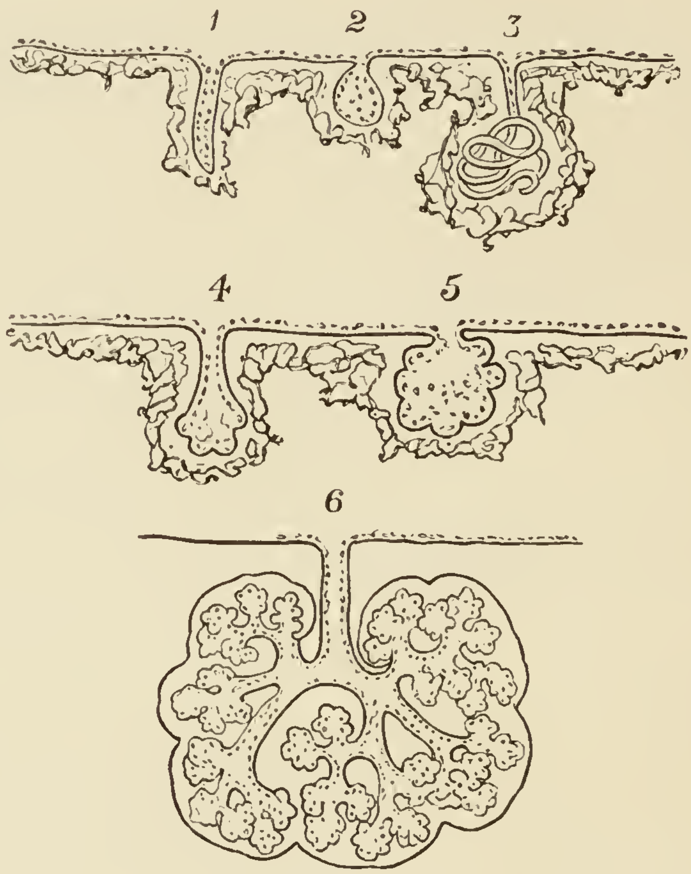


Fig. 27.—Diagram of the Structure of Secreting Glands.

The continuous line represents the basement membrane. The dotted line represents the position of the cells on one side of the basement membrane. The irregular line shows the position of the blood-vessels. 1 shows the simple tubular gland. 2 indicates how the mouth may become shut and a sac formed. 3 represents a coiled tube. 4 and 5 indicate the formation of recesses to produce a sacculated gland, and 6 is a plan of part of a racemose gland. [Sharpey.]

tion they have been divided into six forms, three simple and three compound. The former are the *simple follicle* (fig. 27, 1), the *simple saccule* (2), and the *simple tubule* (3). The latter are the *compound follicle* (4), *compound saccule* (5 and 6), and *compound tubule.* The compound saccule is also known as the *racemose gland.* It consists of lobules arranged on a central duct so as to present the appearance of a cluster of grapes. The glands which secrete the saliva are of this nature.

OSTEOLOGY.

THE DESCRIPTION OF THE BONES.

As man is a vertebrate animal, he is distinguished by the possession of a backbone, or **vertebral column**, commonly known as the **spine**. The upper end of this axial column supports the **skull**; below, it is attached to the **pelvic girdle**, while in the middle it receives the attachment of the **ribs**, and through them supports the **breast-bone**. These together form the **axial skeleton**, the bones of the arms and legs constituting the **appendicular skeleton**. The number of the bones in the body is shown in the following table:

Axial Skeleton	Cranium, ...	8	Skull.
	Face, ...	14	Skull.
	Vertebral column,	24	
	Sacrum and coccyx,	2	
	Hyoid bone, ...	1	
	Sternum and ribs,	25	
Appendicular Skeleton	Upper limbs, ...	64	
	Lower limbs, ...	62	
	Total,	200	

Vertebral Column.—The **Vertebral Column** or spine consists of numerous separate bones, called **vertebræ**, which in the living body are held together by pads of fibro-cartilage, the **intervertebral discs**. At the lower end of the column, the vertebræ become considerably modified, and are welded together to form two bones, the **sacrum** and **coccyx**. For this reason the vertebræ have been divided into the true or free, and the false or fixed vertebræ, and their number and arrangement is shown thus:—

True Vertebræ 24	7 Cervical (neck).	
	12 Dorsal (back).	
	5 Lumbar (loin).	
False Vertebræ 9	5 Sacral	pelvis.
	4 Coccygeal	pelvis.

Characters of a Vertebra.—A vertebra consists of a solid mass or body (**centrum**), from which two processes pass backwards so as to form a ring, the **vertebral canal**, enclosing the spinal cord. The part of this ring near the body of the vertebra on each side is named the **pedicle.** It is grooved on its upper and under surface for the passage of the nerves given off from the spinal cord (**intervertebral notch**). The back part of the ring is formed by somewhat flattened plates, the **laminæ**, and from the junction of these behind there springs a strong process, the **spinous process**, and it is these projections in the series of vertebræ which have given the name of *spine* to the whole column. At the junction of the laminæ and the pedicles, strong pieces of bone jut out horizontally, the **transverse processes**, and near their roots smooth surfaces are seen, by means of which the vertebræ are connected with each other, the **articular processes.** The transverse and spinous processes are chiefly intended for the attachment of the muscles which move the column, but in the dorsal region the former give support also to the ribs.

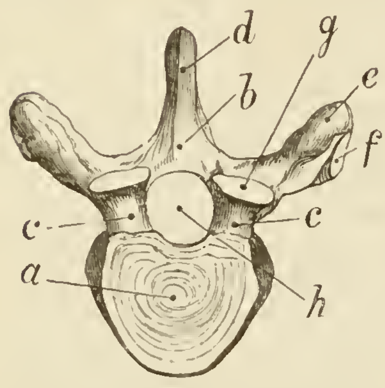


Fig. 28.—A Dorsal Vertebra.

a, Centrum or body; *b*, junction of the laminæ; *c*, pedicles; *d*, spinous process; *e*, transverse process; *f*, depression on the transverse process for the support of a rib; *g*, articular process; *h*, vertebral ring.

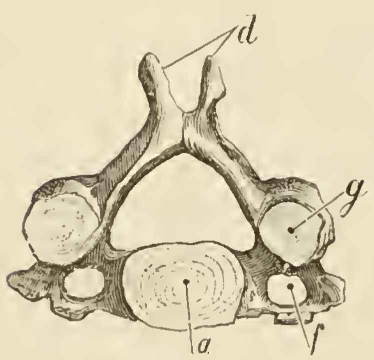


Fig. 29.—A Cervical Vertebra.

a, Centrum or body; *d*, spinous process; *f*, vertebral foramen; *g*, articular process.

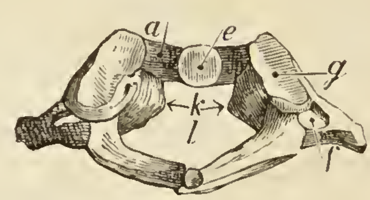


Fig. 30.—The Atlas Vertebra.

a, Anterior arch; *e*, facet for joint with odontoid process; *f*, vertebral foramen; *g*, articular process; *k*, processes for attachment of transverse ligament; *l*, vertebral ring.

The peculiar features of the true vertebræ in each of the three regions will now be described.

Cervical Vertebræ.—The vertebræ of the neck are seven in number, but the first, called **atlas**, and the second **axis**, are so different from the rest as to demand a separate description.

The others are distinguished by the following characters:—the body is thin, hollowed out above, convex below; the spinous processes are short, and are divided into two at their end, excepting the seventh (and often the sixth); the transverse processes are also short and similarly divided; they are deeply grooved on the upper side, and are pierced by a small hole (foramen) for the vertebral artery to pass through. The **first cervical vertebra** or **atlas** is a simple ring of bone without body. At the sides it has above two deep cups for receiving the condyles of the occipital bone (skull), and below, smaller and flatter facets for uniting it with the axis. The spine is a mere rudiment, and the transverse process is strong, long, and undivided. The front part of the ring receives the projecting upper part of the axis. The **axis** or **second cervical vertebra** is distinguished by a tooth-like process projecting from the upper surface of the body, the **odontoid process**, on which the atlas rotates, carrying the head with it. The **seventh cervical vertebra** (*vertebra prominens*) is only notable for the possession of a longer and stronger spinous process than the rest, and which, moreover, is not divided at its extremity.

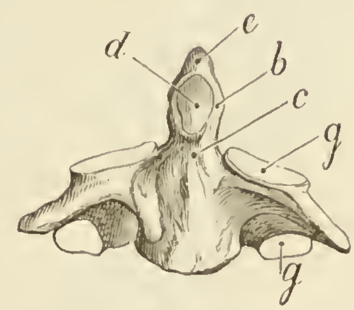


Fig. 31.—The Axis Vertebra.

b, Odontoid process; *c*, its neck; *d*, facet for joint with arch of atlas; *e*, tip of odontoid; *g*, *g*, articular processes.

Dorsal Vertebræ.—There are twelve dorsal vertebræ, and their special character is that they support the ribs. Hence, on each side of the body there are two little depressions (facets), one at the upper border and the other at the lower, for receiving the heads of the ribs; in this way, each vertebra gives support to parts of four ribs. There are, however, exceptions to this rule, for the upper depression on the first vertebra is a whole facet, while on the ninth there is only one half facet on each side, and on the tenth, eleventh, and twelfth

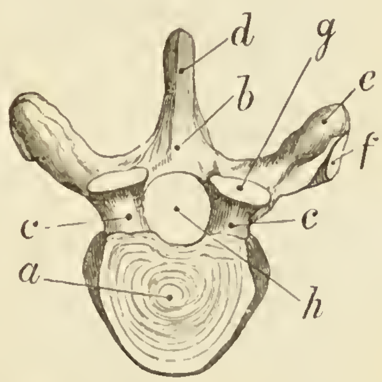


Fig. 32.—A Dorsal Vertebra.

a, Centrum or body; *b*, junction of the laminæ; *c*, *c*, pedicles; *d*, spinous process; *e*, transverse process; *f*, depression on the transverse process for the support of a rib; *g*, articular process; *h*, vertebral ring.

a whole facet on each side. The transverse processes are thick, long, and strong; they are hollowed out at their tips to receive the attachment of the tubercle of a rib, excepting the eleventh and twelfth, which have no connection with the ribs. The spinous processes are long and triangular; they are directed downwards so as to overlap each other.

Lumbar Vertebræ.—The lumbar vertebræ, five in number, are much thicker and stronger than those of the other regions of the spine. They are distinguished from the cervical vertebræ by the absence of the hole in the transverse process, and from the dorsal by their having no facets for ribs. The spinous processes are directed horizontally backwards, and are broad and strong; the transverse processes are long and slender.

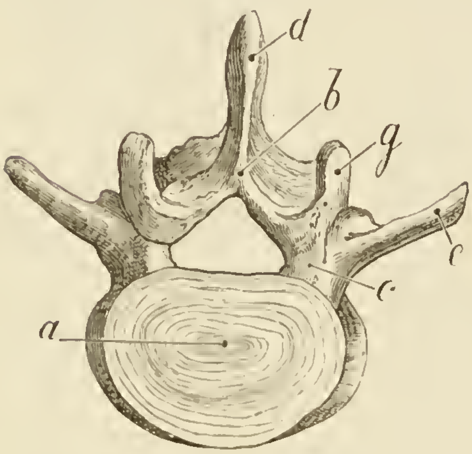


Fig. 33.—A Lumbar Vertebra.

a, Centrum or body; *b*, union of laminæ; *c*, pedicle; *d*, spinous process; *e*, transverse process; *g*, articular process.

The **Sacrum** is formed by the fusion of five vertebræ. It is triangular in shape, with the base directed upwards and the apex downwards; it is concave in front, and convex behind. Its front surface is pierced on each side by four holes for the passage of spinal nerves. Its back surface is rough and irregular, the prominences representing rudimentary spinous and transverse processes; on this surface there are openings for the spinal nerves, similar to those on the front of the bone. The upper end of the bone has an oval surface, for supporting the last lumbar vertebra, and the lower end a similar but much smaller surface for the coccyx. On each side of the bone there is a smooth ear-shaped surface, corresponding to a similar surface on each innominate bone; in the living being these are united to the latter by plates of fibro-cartilage. At the upper part of the sacrum there is a large articular process on each side, by which it is connected with the articular processes of the last lumbar vertebra.

The **Coccyx** is a rudimentary structure representing the tail

bones of other animals. It is formed by the bodies of four vertebræ.

Curves of the Spine.—When the whole of the bones of the spine are joined together by the intervertebral discs, the spinal column is found to present certain permanent curves. These are a *cervical curve*, convex forwards; a *dorsal curve*, convex backwards; a *lumbar curve*, convex forwards; and a *sacral curve*, convex backwards; there is also a slight lateral curve to the right in the dorsal region.

Fig. 34.—The Vertebral Column.

a, Cervical curve; *g*, *g*, *g*, dorsal curve; *b*, lumbar curve. The numbers correspond to those of the vertebræ.

The Skull.—The skull is divisible into two parts, the **cranium** and **face**, the former being constructed for containing the brain, and the latter for supporting the chief organs of sense—the eyes, nose, and tongue.

The **Cranium** is formed of the following eight bones:—

Occipital.
Two Parietal.
Frontal.
Two Temporal.
Sphenoid.
Ethmoid.

Occipital Bone.—This bone is situated at the under part and back of the skull. It is pierced by a large opening, the **foramen magnum**, by means of which the spinal cord is united with the brain, and through which two of the main arteries of the brain (the vertebral arteries) reach the skull. Its upper surface supports the lesser brain and part of the great brain, and is marked by vertical and horizontal ridges for the attachment of membranes of the brain. The under surface of

the bone gives attachment to muscles of the neck, and has two oval articular surfaces or **condyles**, which fit into the cups already described as situated on the upper surface of the atlas.

Parietal Bones.—These are two tabular bones forming the major part of the vault (or rounded upper part) of the cranium (fig. 39, B). They are grooved in the interior by

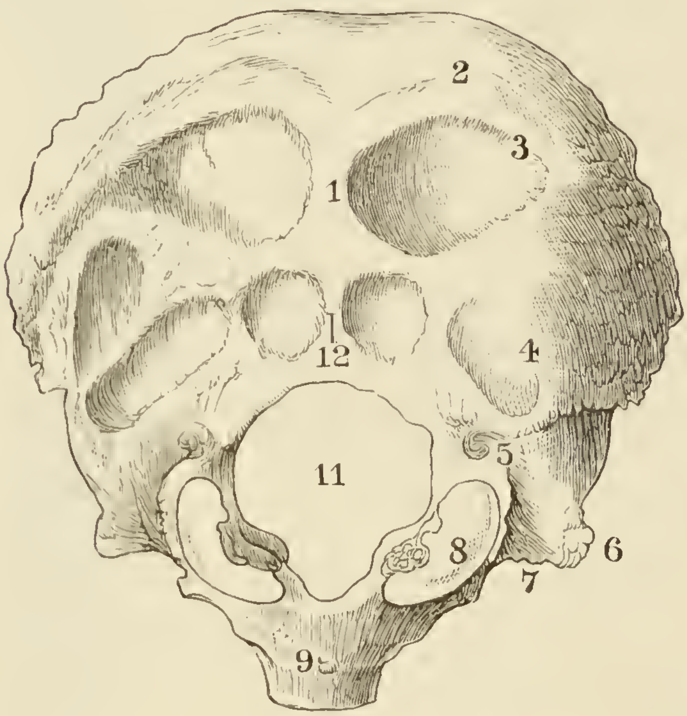


Fig. 35. — Occipital Bone from below.

1, External occipital protuberance; 2 and 3, superior curved line; 4, inferior curved line; 5, posterior condylar foramen; 6, jugular process; 7, groove forming part of jugular foramen; 8, condyle; 9, tubercle for attachment of pharynx; 10, basilar process; 11, foramen magnum; 12, occipital spine. [Quain.]

branching channels, which lodge the arteries of the membranes of the brain.

Frontal Bone.—This bone forms the forehead, and the upper part or roof of the two orbital cavities or eye-sockets (fig. 39, A). Its inner surface is concave, and supports the anterior lobes of the brain. The margins of the orbits are formed by sharp semicircular edges, the **supra-orbital ridges**, and near the inner end of each is either a notch or a small hole, through which pass the supra-orbital vessels and nerves. Above the inner end of these, on each side, are raised and slightly rough bony prominences, the **superciliary ridges**, supporting the inner end of the eyebrows. The middle of the lower part of the bone is hollowed into a cavity, the **frontal sinus**, which, when the bones are joined together, communicates with the cavity of the nose.

Temporal Bones.—These are placed one on each side at the base of the skull, and contain in their interior the organs of hearing. Each temporal bone is divisible into three parts—a thin, scale-like upper portion, called **squamous**, which overlaps the lower edge of the parietal and forms part of the *temple*; a rough back part, projecting downwards in a nipple-like process, the **mastoid**; and a thick and hard triangular mass, the **petrous**, which passes inwards into the interior of the base of the skull. The latter is the densest and hardest bone in the body, and yet is the most frequently broken of all the bones of the skull. At the junction of these three portions is an oval aperture, the external opening of the ear, **meatus auditorius externus**, leading into the cavity of the tympanum in the interior of the bone. In front of this opening is a hollow, the **glenoid cavity**, which gives lodgment to the condyle of the lower jaw, and is bounded in front by a rounded ridge, the **articular eminence**, upon which the condyle moves when the mouth is opened and shut. From the outer surface of the temporal bone a thin, knife-like portion, the **zygoma**, passes forwards to join the cheek-bone, and from its under part a spike projects down, the **styloid process**, to give attachment to certain muscles and ligaments.

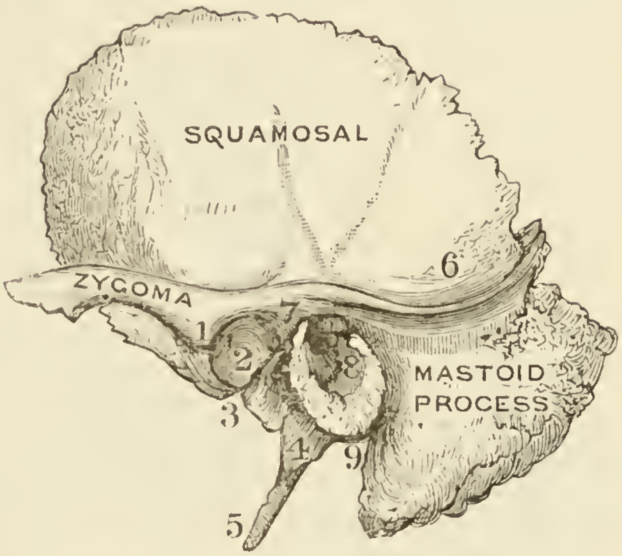


Fig. 36.—Left Temporal Bones, outer view.

1, Tubercle of zygoma; 2, glenoid cavity; 3, fissure of Glaser; 4, vaginal process; 5, styloid process; 6, termination of temporal ridge; 7, middle root of zygoma; 8, external opening of ear; 9, stylo-mastoid foramen.

Sphenoid.—This is a very irregular bone, placed in the front part of the base of the skull (fig. 40, *sph*); it assists in forming the cavities for the eyes and nose, the base of the skull, and the temple; and has numerous nerves and vessels passing through small openings scattered throughout it. Its central part contains two cavities, the **sphenoidal cells**, which are in communication with the cavities of the nose.

Ethmoid.—A very delicate, spongy bone, lying in front of the sphenoid and beneath the frontal. It consists of a sieve-like horizontal plate through the holes of which pass the nerves of smell, and of delicate coiled bones, occupying the cavities of the nose, and on which those nerves are distributed. It also forms the inner wall of each orbital cavity.

The **Face** is formed by fourteen bones—six pairs and two single ones. They are as follows:—

Two Superior Maxillary (upper jaws).
Two Nasal.
Two Lachrymal.
Two Malar.
Two Palate.
Two Turbinated.
One Vomer.
One Inferior Maxillary (lower jaw).

The **Superior Maxillary** bones, or **upper jaws**, form the greater part of the face. Each bone has at its lower border a crescentic ridge of spongy bone, the **alveolar process**, which receives the implantation of the upper teeth. At its upper part is a thin triangular plate of bone, the **orbital process**, forming the floor of the orbit; it is traversed by a groove, terminating on the face in an opening of some size (**infra-orbital groove and foramen**); these lodge the infra-orbital vessels and nerve. On the inner side, a strong but narrow process passes upwards (**nasal process**) to form a part of the nose. At the outer and upper corner this bone unites with the malar or cheek-bone. At the lower part there projects inwards from it an arched

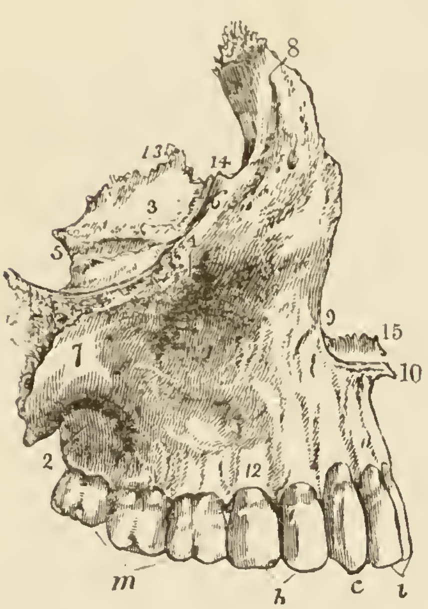


Fig. 37.—Superior Maxillary Bone of the Right Side.

1, Outer surface; 2, posterior surface; 3, orbital plate; 4, infra-orbital foramen; 5, infra-orbital canal; 6, edge of orbit; 7, part which unites with the malar; 8, nasal process; 9, nasal cavity; 10, nasal spine; 11, fossa for one of the muscles of the face; 12, alveolar process; 13, part joined to the ethmoid; 14, nasal duct; 15, palate process; *i*, incisor teeth; *c*, canine; *b*, bicuspids; *m*, molars. [Wilson.]

shelf, the **palate process**, which assists in the formation of the hard palate. In the interior of the bone is a triangular cavity, the **antrum**, communicating with the nasal cavity.

The **Nasal bones** are two very small bony scales which form the bridge of the nose.

The **Lachrymal** are two minute, scale-like bones, placed immediately within the inner margin of each orbit; they are grooved to give lodgment to the tear-sacs (lachrymal sacs).

The **Malar** or cheek-bones are the chief cause of the lateral projection of the cheeks just below the eyes; each bone connects the zygoma of the temporal with the upper jaw.

The **Palate bones** (two in number) are very small and irregular bones, forming the back part of the hard palate, and the back part of the lateral walls of the nasal cavities, as well as a small portion of the floor of the orbits.

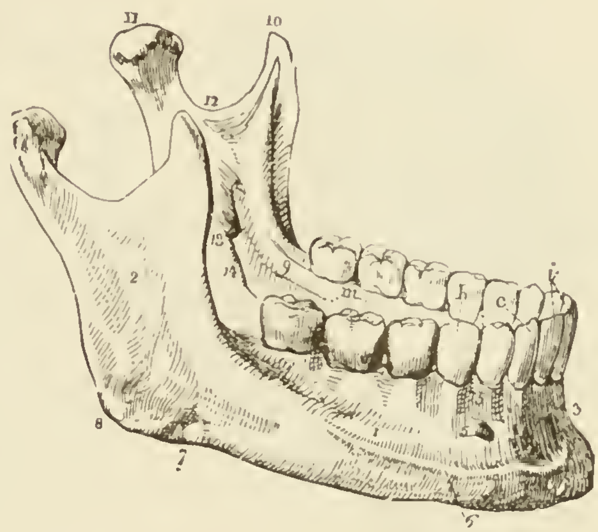


Fig. 38.—Lower Jaw.

1, Body; 2, ramus; 3, symphysis; 4, fossa for one of the muscles of the face; 5, mental foramen; 6, oblique ridge; 7, groove for facial artery; 8, angle; 9, mylo-hyoid ridge; 10, coronoid process; 11, condyle; 12, notch; 13, inferior dental foramen; 14, groove for a small artery and nerve; 15, alveolar process; *i*, incisor teeth; *c*, canine; *b*, bicuspids; *m*, molars. [Wilson.]

The **Turbinated** are two small curved bones attached to the outer walls of the nasal cavities; their only purpose is to give greater surface on which the mucous membrane of the nose may be spread out.

The **Vomer**, a single bone, lies in the middle of the face bones, and serves to divide the right nasal cavity from the left. It is connected above with the under surface of the sphenoid, and below with the superior maxillary and palate bones.

The **Inferior Maxillary**, or **lower jaw**, is the largest bone of the face, and the only movable bone of the skull. It consists of two lateral halves, absolutely alike in every respect; these two parts are formed separately, but join together about the end of the first year of life, the line of their union being called the sym-

physis. The horizontal part of the bone is called the **body**; it is thick and strong, but bears on its upper border the soft, spongy **alveolar process** (similar to that in the upper jaw) for the implantation of the teeth. Passing upwards on each side is a vertical process, the **ramus**, the junction of which with the body is the **angle**. The ramus divides at its upper end into two processes; the anterior, sharp and pointed, called the **coronoid process**, is for the attachment of the temporal muscle; the posterior one, rounded and thick, is the **condyle**, and by its means the lower jaw articulates with the temporal bone. Two openings for nerves and vessels are found on each half of this bone—one on the inside of the angle for the inferior dental nerve and artery, and the other on the outside of the body for the mental nerve and artery.

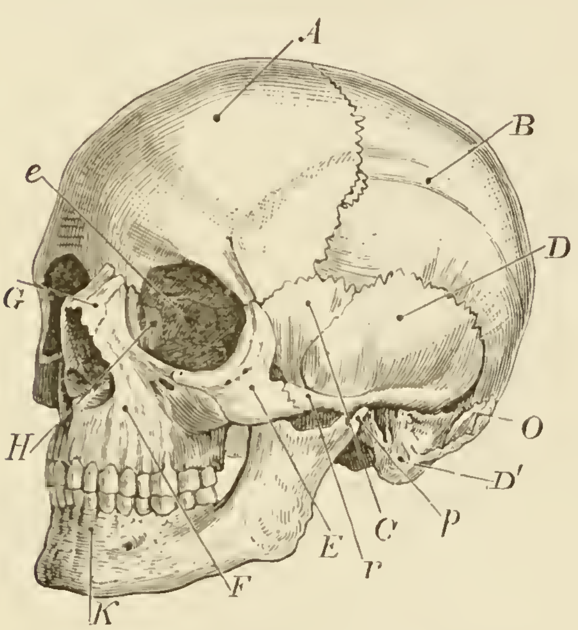


Fig. 39.—The Skull, viewed from the side.

A, Frontal bone; *B*, parietal; *C*, sphenoid; *D*, temporal (squamous); *D′*, mastoid of temporal; *E*, malar; *F*, upper jaw; *G*, nasal; *H*, lachrymal; *O*, occipital; *e*, ethmoid; *K*, lower jaw; *r*, zygoma; *p*, condyle of lower jaw.

The Skull as a whole.—The whole of the bones of the skull have now been described individually, but it will be instructive to take another glance at them as they are united together in the formation of the cranium and face. The completed skull may be looked at in at least six aspects, namely:—from above (*vertex*), on either side (*two lateral views*), from below (*base*), from within, looking downwards (*inner surface of base*), and from the front (*face*).

The **vertex** (as the top of the skull is called) is formed by the frontal, two parietal, and upper part of the occipital bone.

In the side **view** we notice that all the bones of the cranium are visible excepting the ethmoid. Towards the front of the skull the lateral region is divided into two by the zygoma. Above that process there is a large hollow, corresponding to the position of the "temple"; it is called the **temporal fossa**,

and in the living person is occupied by the temporal muscle, one of the chief muscles of mastication. Below the zygoma we notice the ramus of the lower jaw, and behind this the external opening of the ear (external auditory meatus) and the mastoid process.

On turning the skull upside down and examining the **base**, we observe at the back the rough surface on the occipital bone for the muscles of the neck, and in front of this the large opening of the foramen magnum, with the oval condyles placed one on each side of its anterior part. In front of the occipital bone will be noticed the rugged and dense petrous portions of the temporal bones, with the basal portion of the occipital and sphenoid between them. Between the occipital and temporal of each side is a large irregular opening, the **jugular foramen**, for the passage of the jugular vein and 9th, 10th, and 11th cranial nerves; and in the petrous bone itself is a curved canal, with two openings, for the internal carotid artery. In front of the petrous bones is the under surface of the sphenoid, pierced by numerous openings for the passage of vessels and nerves. If the lower jaw be removed, it will be seen that the part of the base of the skull formed by the bones of the face is carried downwards to a much lower level than the rest of the skull; the projection thus formed is the **hard palate**. It is made up of the palate processes of the superior maxillary and palate bones, is bounded by the alveolar processes and teeth, which form a horse-shoe curve around it, and is concave, as viewed from below.

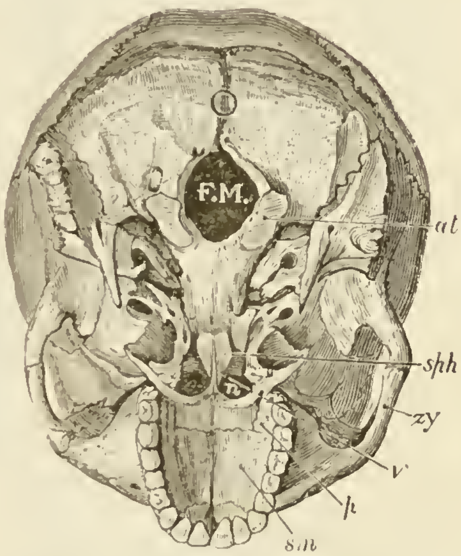


Fig. 40.—The Base of the Skull.

F.M., Foramen magnum; *at*, occipital condyle for articulating with the atlas; *sph*, sphenoid; *zy*, zygoma; *v*, vomer; *p*, palate bone; *sm*, palate process of superior maxilla; *n*, posterior nares.

The **inner surface of the base** of the skull differs in many important respects from the outer surface. It is divided into three hollows or fossæ, the anterior being the shallowest and

the posterior the deepest. The **anterior fossa** forms the roof of the orbits, and has in the centre of it the sieve-like plate of the ethmoid, on which lie in the living body the olfactory bulbs, giving off the nerves of smell. The **middle fossa** is formed by the sphenoid and temporal bones, and supports the middle lobes of the brain; at its anterior limit there is a long slit (**sphenoidal fissure**) leading into the orbit, and through

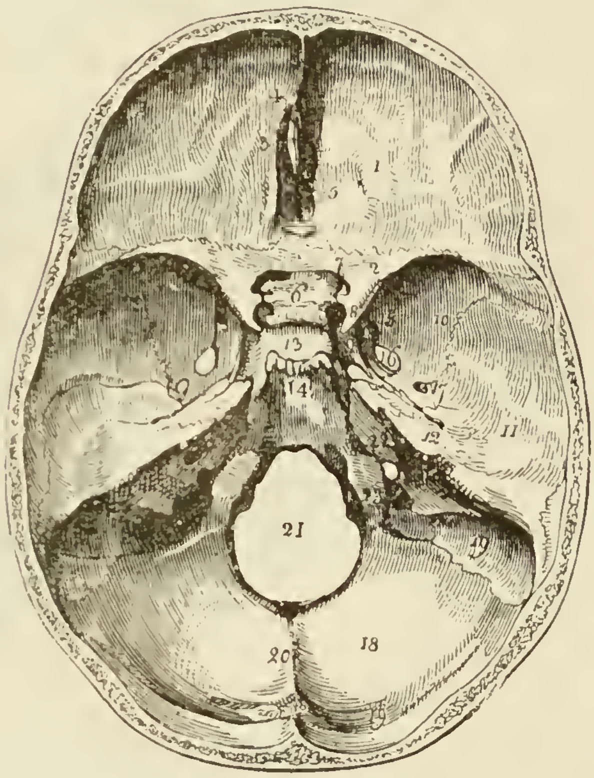


Fig. 41.—Interior of Base of Skull.

1, Anterior fossa; 2, lesser wing of sphenoid; 3, 4, 5, different parts of ethmoid; 6, groove for the nerves of sight; 7, optic foramen; 8, process to which the dura mater is attached; 9, groove for internal carotid artery; 10, middle fossa; 11, squamous part of temporal; 12, petrous bone; 13, body of sphenoid; 14, basilar part of sphenoid and occipital; 15, 16, openings for branches of the fifth nerve; 17, opening for the middle meningeal artery; 18, posterior fossa; 19, groove for lateral sinus; 20, ridge for dura mater; 21, foramen magnum; 22, internal opening of ear; 23, jugular foramen. [Wilson.]

this, and through a neighbouring small circular hole (**optic foramen**), the vessels and nerves reach the eyeball and the structures around it. The **posterior fossa** is formed by the occipital bone and a small portion of the two temporal bones; it receives the lesser brain, and is pierced by the foramen magnum and the two jugular foramina.

The **Face** is formed by the frontal, superior maxillary, nasal, malar, and inferior maxillary bones. At the upper part are the two large pyramidal cavities, the **orbits**, which receive the eyes and their vessels and nerves. Each orbit is bounded above by a sharp edge, the **supra-orbital ridge**, and at the inner third of this border is a notch (sometimes a small hole), through which the supra-orbital nerve passes. The lower edge of the orbit is formed by a similar ridge, and beneath this is

the opening already described as the infra-orbital foramen for the infra-orbital nerve. In the middle line is the opening of the **nose**, formed by the margins of the superior maxillary and nasal bones; it is shaped like a leaf turned upside down, and is very large as compared with the opening into the nasal cavities when the skin, muscles, and cartilages are present. Within the opening of the nose can be seen the front edge of the vomer (in the middle line), and the tip of the two turbinated bones.

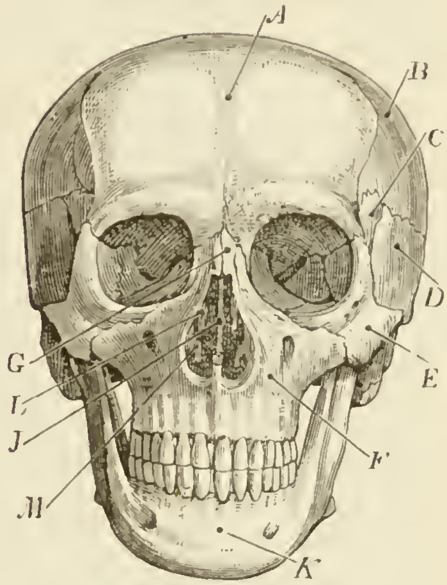


Fig. 42.—The Skull, viewed from before.

A, Frontal bone; *B*, parietal; *C*, sphenoid; *D*, temporal; *E*, malar; *F*, upper jaw; *G*, nasal; *J*, vomer *K*, lower jaw; *L*, turbinated bone of ethmoid; *M*, inferior turbinated.

Hyoid Bone.—This is a small **U**-shaped bone detached from the rest of the skeleton, and situated in the upper part of the neck, in close connection with the base of the tongue, and more loosely with the larynx (voice-box).

The Thorax or Chest. — The skeleton of the chest or thorax consists of the dorsal vertebræ, the breast-bone or sternum, the ribs, and costal cartilages.

Sternum or Breast-bone.—This is a flat bone placed in the middle of the front wall of the chest. At the upper border it supports and is jointed to the collar-bones; on each side it receives the costal cartilages of the true ribs; while below, a pointed or divided process, the **xyphoid cartilage**, passes from it into the upper part of the abdominal wall. Its anterior surface is crossed by five slightly-raised lines, indicating that it originally was formed in six separate pieces. Its upper border, between the two collar-bones, is marked by a hollow, the **supra-sternal notch**.

Ribs.—The ribs are twelve on each side. The first seven are connected with the sternum by costal cartilages, and for this reason are called **sternal** or **true ribs**; the remaining five are **asternal** or **false ribs**. The last two are only connected with the bodies of the vertebræ, and not with the transverse

processes, and hence are termed **floating ribs.** Each rib is bent, and forms a segment of a circle; it is also slightly twisted on itself, so that when placed on a table it only touches the surface at one or two points. The end of the rib which is attached to the body of the vertebra is called the **head.** Beyond this is a narrower constricted part, the **neck,** followed by a **tubercle,** which in most of the ribs rests against the transverse process of the vertebra. Where the rib bends forwards there is a rough ridge on the back of it, named the **angle.** The upper edge of the rib is rounded, the lower is grooved, and in the groove run the intercostal artery and nerve. The ribs increase in length from the first to the eighth, and then diminish to the twelfth. The first is nearly horizontal, the rest slope downwards as they pass forwards. The first rib is marked on its upper surface by two grooves separated by a ridge. The groove in front of the ridge is for the subclavian vein, that behind it for the subclavian artery, and the ridge itself gives attachment to the anterior scalene muscle.

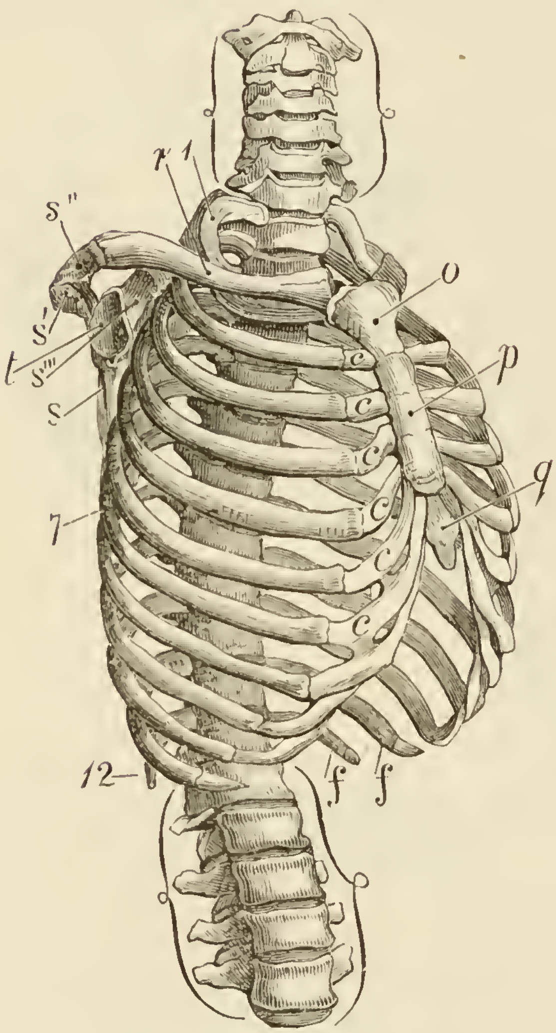


Fig. 43.—The Thorax.

The upper vertebræ enclosed in brackets are cervical, the lower lumbar. 1, First rib; *c, c,* costal cartilages; *f, f,* floating ribs; *o, p,* upper and middle portions of sternum; *q,* xyphoid cartilage; *r,* clavicle; *s,* scapula; *s′,* spine of scapula; *s″,* acromion process; *s‴,* glenoid cavity; *t,* front of scapula; 7, 12, the seventh and twelfth ribs.

Costal Cartilages.—These are the means by which the ribs are prolonged forwards to the sternum. The cartilages diminish in breadth from the first to the last, and the lower ones are more rounded than the upper. The first seven are connected with the sternum, the eighth is united to the seventh, the ninth to the eighth, and the tenth to the ninth.

The two last merely tip the ends of the two last ribs, and are not connected with each other. The costal cartilages from the seventh to the tenth form an elastic arch in the upper part of the abdominal wall, and the ensiform or xyphoid cartilage is placed between the upper terminations of the lateral segments of this arch.

The Thorax or Chest as a whole.—The thorax is cone-shaped, but flattened from before backwards. It has its widest measurement from side to side. The front wall, formed by the sternum and costal cartilages, is much shorter than the back wall, formed by the dorsal vertebræ and ribs. The vertebral bodies project into the cavity from behind, and hence there is a posterior recess on each side, which is occupied by the back part of the lungs. In consequence of the obliquity of the ribs, the upper end of the sternum corresponds to the level of the lower part of the body of the second dorsal vertebra in the male, and to the lower part of the body of the third in the female. For this reason the neck has the appearance of being longer in the female than in the male. The female thorax is relatively shorter and rounder than the male, and is also relatively wider in its upper part. The lower part of the chest wall encloses the upper part of the abdominal cavity.

The Upper Limb.—The upper limb is formed by the collar-bone or clavicle, blade-bone or scapula, arm-bone or humerus, forearm bones or radius and ulna, and the bones of the hand—wrist-bones or carpus, metacarpus and phalanges. The clavicle and scapula form the *shoulder-girdle.*

Clavicle or Collar-bone.—This is a long curved bone, passing outwards, horizontally, from the sternum to the blade-bone. It is thick and prominent where it joins the sternum, thinner and flattened at the outer end where it joins the blade-bone. It has a long, forward curve near its middle, and a short, backward curve near its outer end. Near its outer end it is rough on the under surface, from the attachment of strong ligaments which bind it to the coracoid process of the scapula. Its anterior surface gives rise to part of the great pectoral muscle, and to its outer part the deltoid and trapezius muscles

are attached, while at the inner end it gives origin to the great muscle of the neck, the sterno-mastoid.

The collar-bone supports the shoulder, and, by carrying the

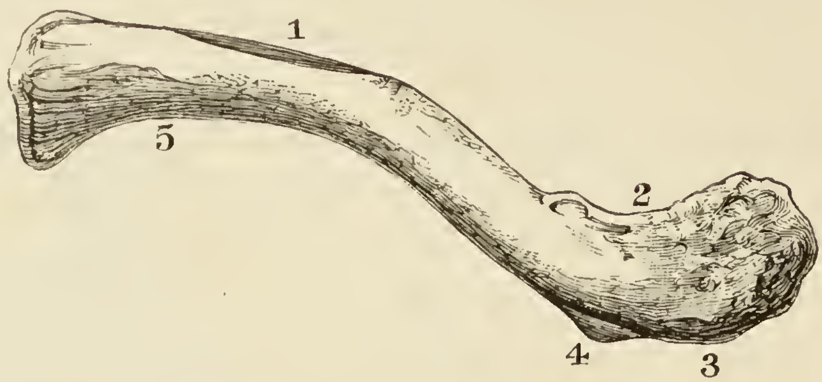


Fig. 44.—Right Clavicle, from above.

1, Greater curve; 2, lesser curve; 3, attachment of deltoid; 4, tubercle for coraco-clavicular ligaments; 5, sternal end.

glenoid cavity of the scapula well away from the chest wall, gives to the shoulder-joint the great freedom of movement it enjoys. Falls on the shoulder or upper part of the arm frequently produce fracture of this bone.

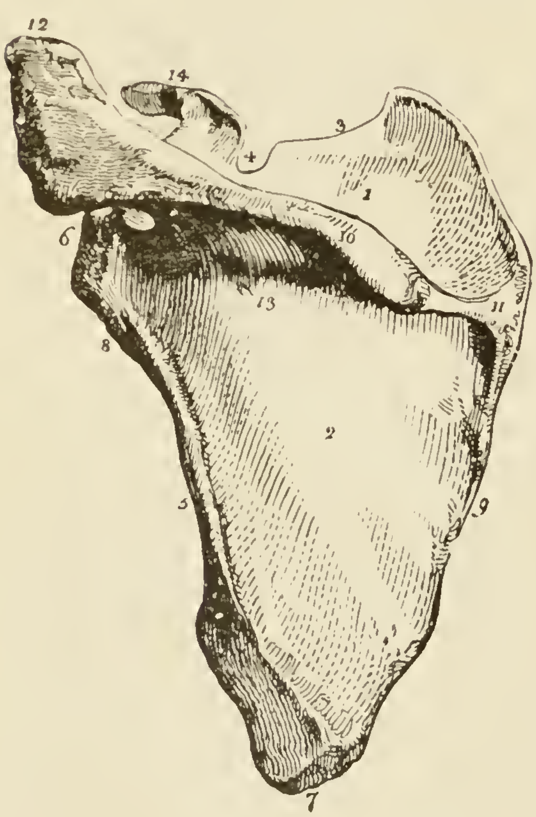


Fig. 45.—Posterior Surface of Scapula or Shoulder-blade.

1, Supra-spinous fossa; 2, infra-spinous fossa; 3, upper border; 4, notch; 5, axillary border; 6, glenoid cavity; 7, inferior angle; 8, neck, the part to which the triceps is attached; 9, vertebral border; 10, spine; 11, triangular smooth area over which the trapezius muscle glides; 12, acromion; 13, nutrient foramen; 14, coracoid. [Wilson.]

Scapula or Blade-bone.—The shoulder-blade is a triangular bone placed at the back of the shoulder, and connected with the rest of the skeleton by means of the collar-bone alone. It rests on the upper part of the chest-wall, but is separated from the ribs by muscles. Of its three borders, one (superior) looks upwards, the second (vertebral) backwards, and the third (axillary) downwards and outwards. At the upper end of

the axillary border is a pear-shaped, slightly concave surface, the **glenoid cavity**, supported by a strong buttress of bone. This cavity receives the head of the humerus in the formation of the shoulder joint. At the upper part of the glenoid cavity one head of the biceps muscle is implanted, and the triceps is connected with a rough impression below that cavity. The triangular blade of the scapula is divided on its posterior surface into two unequal parts by a strong ridge of bone, which crosses it, the **spine** of the scapula. This ridge gives attachment by its upper edge to the trapezius muscle, and by its lower one to the deltoid. The upper and smaller division is called the **supra-spinous fossa**, and lodges the supra-spinous muscle; the lower and larger part forms the **infra-spinous fossa** for the infra-spinous muscle. The spine of the scapula as it passes upwards and forwards spreads out into a prominent process, the **acromion**, which overhangs the glenoid cavity and supports the outer end of the clavicle. Above, and to the inner side of the glenoid cavity, is a hook-like projection, the **coracoid process**. This gives attachment to the lesser pectoral, coraco-brachialis, and biceps muscles, and is connected with the under surface of the collar-bone by strong ligaments. The front surface of the scapula forms the back of the cavity of the arm-pit, and is covered by a muscle, the subscapularis.

Fig. 46.—The Humerus.

a, Head; *b*, lower articular surface for the ulna; *c*, shaft; *d*, greater tuberosity; *e*, surgical neck; *f*, anatomical neck; *g*, external condyle; *h*, internal condyle.

Humerus or Arm-bone.—This is a long bone, having at its upper end a rounded **head** for uniting with the scapula in the shoulder-joint; below this a long cylindrical **shaft**, to which muscles are attached; and, at the lower end, pulley-like surfaces for receiving the bones of the forearm. The rounded head has at its outer side two irregular prominences separated by a groove. The groove is called **bicipital** from its being occupied by the long tendon of the biceps muscle. The larger

and outer prominence is the **greater tuberosity**, for the attachment of the external rotator muscles, and the smaller one the **lesser tuberosity**, for the internal rotator muscle. The constriction round the articular surface is called the **anatomical neck**, that between the head and the shaft the **surgical neck.** The shaft is marked at the back by a wide, shallow groove, the **musculo-spiral groove**, for the musculo-spiral nerve and a small artery. The muscles attached to the shaft of this bone are —at about the middle of the outer side, the deltoid; the corresponding point on the inner side, the coraco-brachialis; the back of the bone, the triceps; and the lower part in front, the brachialis anticus. The lower end of the humerus has two articular surfaces; the inner, shaped like a pulley (**trochlea**), for the ulna, and the outer, small and rounded (**capitellum**), for the radius. Projecting on each side of the lower end is an irregular prominence, the **outer** and **inner condyle**; the former serves for the origin of the extensor and supinator muscles of the forearm, the latter (much the longer and more prominent) for the flexors and pronators.

Fig. 47.—The Ulna and Radius.

The bones are shown displaced from one another in the figure. The radius (2) is above its proper position. Its head should move on the side of the ulna below the level of the hollow (*c*). 1, Ulna; 2, radius; *a*, olecranon; *b*, coronoid process; *c*, sigmoid notch; *d*, surface for articulation with head of radius; *e*, tubercle of radius; *f*, head of radius; *g*, lower end of radius; *h*, neck of radius; *i*, articular surface for lower end of ulna; *k*, styloid process of radius; *l*, styloid process of ulna.

Bones of the Forearm (Ulna and Radius).—The bones of the forearm are two in number, the ulna and radius. The ulna is the largest of the two at the elbow, but is much the smallest at the wrist, the conditions being reversed with the radius. In this way the ulna takes the chief part in the formation of the elbow-joint, and the radius in the formation of the wrist-joint. When the palm of the hand is directed upwards the radius is the outer and the ulna the inner bone, and this is regarded as their proper anatomical position.

Ulna.—This bone is easily distinguished by the hollow

sigmoid notch, at the upper end, which receives the lower end of the humerus. Jutting out behind and above this is a strong process, the **olecranon**, which forms the tip of the elbow, and gives attachment to the triceps muscle. Below, and in front of the articular hollow, is another strong piece of bone, the **coronoid process**. It gives attachment to the brachialis anticus muscle, and has on its outer side a smooth depression to receive the head of the radius (fig. 47, *d*). The **shaft** of the ulna is triangular, and is completely surrounded by the muscles passing to the hand. The lower end forms a small rounded head on which the lower end of the radius moves; projecting downwards from it is a small spike-like process, the **styloid process**.

Fig. 48.—Back of the Ulna and Radius.

1, Shaft of ulna; 2, olecranon; 3, sigmoid notch; 4, ridges for interosseous membrane; 5, part of ulna articulating with lower end of radius; 6, styloid process of radius; 7, shaft of radius; 8, its head; 9, neck; 10, tubercle; 11, lower end; 12. ridge separating tendons; 13, styloid process of radius. [Wilson.]

Radius.—Easily recognized by the rounded upper end, and the thick, strong, and grooved lower end. The upper end has a smooth edge all round, one portion articulating with the depression on the outer side of the upper part of the ulna, and the remainder being embraced by the orbicular ligament. At the extremity is a cup-like hollow, which receives the outer articular eminence of the humerus. The **shaft** is three-sided, and gives attachment to the muscles on the front and back of the forearm. Its inner edge is sharp, and has attached to it the **interosseous membrane** connecting the two forearm bones. At the inner side of the shaft, a little below the head, is an elevation or **tubercule**, into which is inserted the tendon of the biceps; and at the outer side, near the middle, is a rough impression for the round pronator muscle. The lower end of the bone is thick and strong, and is grooved on

the back for the tendons of the extensor muscles. The extremity is hollowed out into a smooth cavity for receiving the two outer bones of the wrist. Projecting from the outer side of this end of the bone is a strong process, called **styloid**, which protects the wrist-joint, and gives attachment to the external lateral ligament of the joint.

The Hand.—The hand consists of the following bones:—

Wrist or carpus,	8
Metacarpals,	5
3 phalanges in each finger,	12
2 phalanges in the thumb,	2
	27

Carpus or Wrist.—The bones of the **carpus** are small irregular bones; they are arranged in two rows of four each, and are named from their shape and appearance.

	(Outer side.)			(Inner side.)
First row.—	Scaphoid	Semilunar	Cuneiform	Pisiform.
Second row.—	Trapezium	Trapezoid	Os Magnum	Unciform.

The **Scaphoid** has a slight resemblance to a boat, with the prow directed outwards and forwards. The **Semilunar** is half-moon-shaped. These two bones fit into the hollow at the end of the radius.

The **Cuneiform** is somewhat wedge-shaped, and is sometimes called the **pyramidal bone**. It is separated by a thin triangular cartilage from the end of the ulna.

The **Pisiform** (shaped like a pea) does not lie in the same plane as the other three, but is placed on the front of the cuneiform. It is really an osseous formation in the tendon of a muscle.

The **Trapezium** (named from its irregular four-sided shape) is the bone which supports the thumb. It is grooved in front for the tendon of one of the flexor muscles of the wrist. The **trapezoid** is a small and very irregular bone.

The **Os Magnum**, the largest of the carpal bones, is placed in the midst of them, and is known by having a rounded head and below it a constricted neck.

The **Unciform** has a projecting hook in front, and is the only bone of the wrist which supports two metacarpals, namely, those of the ring finger and little finger.

The carpal bones are broad and flattened behind, narrower and irregular in front. On the palmar (or anterior) aspect of the wrist the prominence of the scaphoid and trapezium on the outer side and the pisiform and unciform on the inner leave between them a groove in which lie the tendons of the muscles and the main nerves of the palm, being bridged over by a ligament (the **annular ligament**) passing from the one prominence to the other.

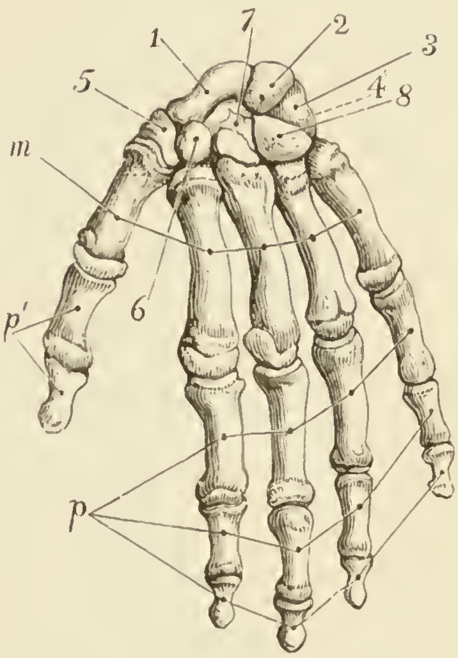


Fig. 49.—The Hand, from behind.

1, Scaphoid; 2, semilunar; 3, cuneiform; a dotted line leading to 4 shows the position of the pisiform bone, which rests on the cuneiform, and can be seen only from the front; 5, trapezium; 6, trapezoid; 7, os magnum; 8, unciform; *m*, the five metacarpal bones; *p*, phalanges of fingers; *p'*, phalanges of thumb.

The **Metacarpal** are long bones with square bases, triangular shafts, and rounded heads. Those of the fingers lie close together, and have little freedom of movement; that of the thumb deviates from the others, and is freely movable.

The **Phalanges** (finger-bones) form the joints of the fingers. They are flattened in front, rounded behind, and have grooved articular ends; the last phalanges have at the back a rough crest which supports the matrix of the nail.

The Lower Limb.—The lower limb is formed by the innominate or haunch-bone, the femur or thigh-bone, the patella or knee-cap, the tibia and fibula or leg-bones, and the bones of the foot, consisting of the tarsus or ankle-bones, metatarsus, and phalanges. The haunch-bones of the two sides of the body, with the sacrum and coccyx, form the **pelvis.**

The **Innominate** or **haunch-bone** is of very irregular shape. When first formed it consisted of three pieces, and it is convenient, for descriptive purposes, to still retain the names which the three separate pieces had. Thus we have a broad

expanded part, which projects upwards and outwards, the **ilium**; a rough and strong portion, passing downwards and backwards, and forming the support of the body in the sitting posture, the **ischium**; and a part which passes inwards and forwards to unite with its fellow of the opposite side in the middle line, the **pubes**. Where these three parts join there is a cup-shaped cavity for receiving the round head of the thigh-

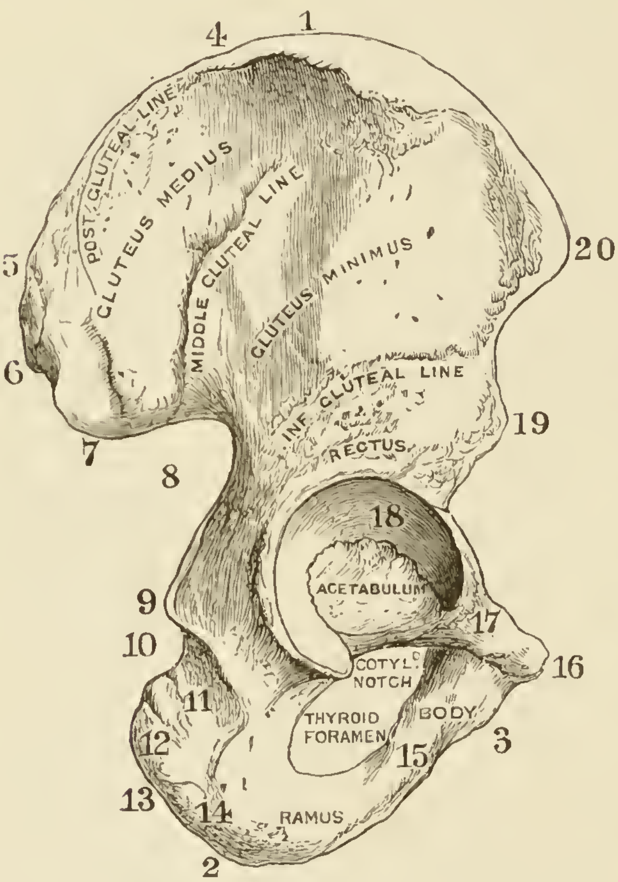


Fig. 50.—Innominate Bone, from above.

1, Ilium; 2, ischium; 3, pubes; 4, crest of ilium; 5, attachment of gluteus maximus; 6, posterior superior spine; 7, posterior inferior spine; 8, great sciatic notch; 9, spine of ischium; 10, lesser sciatic notch; 11, attachment of biceps and semi-tendinosus; 12, attachment of semi-membranosus; 13, tuberosity of ischium; 14, origin of great adductor; 15, ramus of pubes; 16, symphysis pubis; 17, ilio-pectineal line; 18, surface of acetabulum lined with cartilage; 19, anterior inferior spine; 20, anterior superior spine. [Quain.]

bone; this is the **acetabulum** The **ilium** has at its upper limit a strong, rough, crescentic border, the **crest of the ilium**, into which the strong muscles forming the abdominal wall are implanted. The anterior extremity of this crest forms a projection called the **anterior superior spine** of the ilium, which is taken as the fixed point from which measurements of the lower limb are made; it also gives attachment to Poupart's ligament. Beneath this spine is another, the **anterior inferior spine**. The outer side of the ilium gives attachment to the muscles of the buttock (**gluteal**), and the inner surface forms the **iliac fossa**, and lodges the iliacus muscle. The **ischium** is distinguished by a rough, strong, inferior process, the **tuberosity of**

the **ischium**, which gives attachment to the ham-string muscles; above this a notch, and, higher still, a sharper, thinner process, the **spine of the ischium.** From the tuberosity a flattened and comparatively thin piece of bone passes forwards and upwards to meet a similar process descending from the pubes, the two together forming the **ramus of the ischium and pubes.** The two pubic bones, as mentioned above, unite in the middle line; the part by which they join is called the **symphysis pubis.** Running outwards from this, on the upper edge of the bone, is a rough ridge, the **crest of the pubes,** and this terminates externally in a sharp projection of bone, the **spine of the pubes,** which gives attachment to the inner end of Poupart's ligament, and marks the situation of the external abdominal ring. Between the pubes and the ischium is a triangular or oval opening, the **obturator,** or **thyroid foramen;** at the upper part of this is a groove, on the under surface of the pubic bone, in which lie the obturator vessels and nerve. In the living being the whole of the foramen, with the exception of this groove, is closed by a membrane. At the back of the ilium and ischium are two notches, one above and the other below the spine of the ischium; these are the **greater** and **lesser ischiatic notches.** They are converted into foramina by ligaments in the completed pelvis.

The Pelvis.—The pelvis is formed by the two innominate bones, the sacrum and coccyx. Its position in relation to the axis of the body is oblique, as shown in the figure of the skeleton at the end of the book. The branches (**rami**) of the pubic and ischiatic bones form an arch, which is much wider in the female pelvis than in the male; beneath this arch the head of the child passes in the process of birth. When the completed pelvis is viewed from behind it will be seen that two strong ligaments take part in its completion; these are the **greater** and **lesser sciatic ligaments**; they convert the notches above described into foramina, the upper (**greater sciatic foramen**) giving passage to the gluteal nerve and vessels, sciatic nerves and vessels, pudic nerve and vessels, and a small muscle, and the lower (**lesser sciatic foramen**) to the obturator muscle and pudic vessels and nerves.

When the pelvis is viewed from above it is seen that a salient line serves to mark the separation of ilium and ischium on the inner aspect, this is the **ilio-pectineal line**; the part below this line forms the **true pelvis**, the part above it the **false pelvis**; further, this line marks the boundary of the upper limit of the cavity of the pelvis, and therefore forms the **brim of the pelvis.** The lower opening of the pelvis is called the **outlet**; it is bounded by the pubic arch in front, the tuberosity of the ischium and great sciatic ligament on each side, and the coccyx behind. The **cavity of the pelvis** is the space between the inlet and the outlet; it is bounded behind by the sacrum, on each side by the ischium and sciatic ligaments, and in front by the pubic bones. The spines of the ischia project into the cavity on each side, and cause the formation of two planes or grooves (one in front and another behind each spine), down one or other of which the head of the child travels in the process of birth.

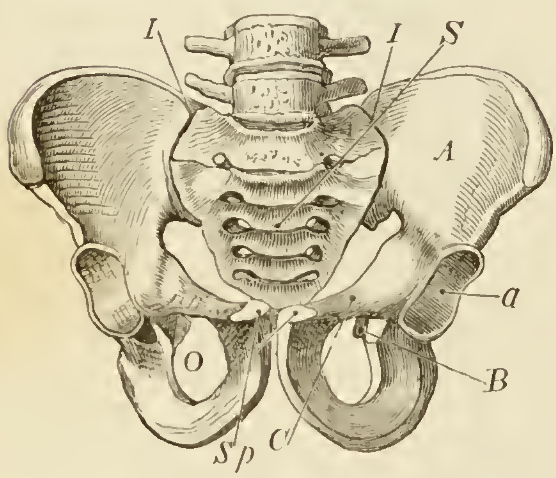


Fig. 51.—The Pelvis.

A, Ilium; *B*, spine of ischium seen through obturator foramen; *S*, sacrum; *I*, sacro-iliac joint; *Sp*, symphysis pubis; *O*, obturator foramen; *C*, the part of the pubes crossed by the femoral vessels. *a*, Acetabulum.

There are certain noteworthy differences between the male and female pelvis; the chief of these are as follows:—In the female the bones are lighter, the iliac bones are more spread out, so that the pelvis as a whole is wider; the cavity is wider than in the male, but not so deep; the pubic arch is wider; the tuberosities of the ischia are wider apart, the acetabula more widely separated, the sacrum is broader and more curved, and the obturator foramen is triangular.

The Femur or Thigh-bone.—This is the longest, heaviest, and strongest bone in the body. Like all long bones it consists of a shaft, upper extremity, and lower extremity. The upper end is formed into a rounded **head**, connected with the shaft by a pyramidal **neck.** The **head** forms a larger segment

of a circle than does the head of the humerus, is more definitely separated from the shaft of the bone, and fits more accurately to its cavity, the acetabulum. A little below its centre is a triangular depression for the attachment of the **round ligament (ligamentum teres)**. The point where the neck joins the shaft is indicated in front by a rough line (**spiral line**) and behind by a well-marked ridge (**inter-trochanteric ridge**). The capsule of the hip-joint covers the whole of the neck of the femur in front, but only the inner half behind. The upper end of the shaft has a rough, strong, projecting process, the **great trochanter**, which gives attachment to the gluteal and external rotator muscles. Behind, and on a lower level, is a smaller process, the **lesser trochanter**, to which are attached the tendons of the psoas and iliacus muscles. The **shaft** of the bone is rounded in front, and expands as it passes downwards; behind it is produced into a ridge, the **linea aspera**, which is rendered rough by the attachment of the great muscles which form the flesh of the thigh. The **lower end** of the bone is incompletely divided into two by a deep notch, which is seen at the back and below, but does not extend to the front, the **inter-condylar notch**. The two parts so separated are called the **external** and **internal condyle**; the former is the broader and shorter, the latter the longer and narrower. In front of the lower end a broad grooved surface is found on which the knee-cap glides in the movements of the knee-joint (**patellar surface**). The condyles are rounded behind, and are so shaped as to be adapted for flexion and extension, the characteristic movements of the knee.

Fig. 52.—The Femur.

A, The shaft; 1, the head; 2, great trochanter; 3, lesser trochanter; 4, neck; 5, outer condyle; 6, inner condyle; 7, patellar surface.

The **Patella**, or **knee-cap** (knee-pan), is somewhat triangular in shape, with a pointed lower end, which is united to the tibia by a strong ligament. The posterior surface is smooth, and is

divided into facets for the two condyles; in the living body this surface is coated with cartilage, and forms part of the knee-joint. The patella has attached to it the great extensor muscles of the leg, and may be regarded as an ossification in the tendons of those muscles.

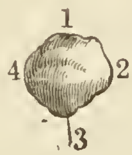


Fig. 53.—Patella of Left Leg.

1, Upper border for attachment of extensor muscles; 2, outer border; 4, inner border; 3, pointed end for ligamentum patella.

The bones of the leg are the **tibia** and **fibula.** The former is a large, strong, triangular bone, and is situated on the inner side; the latter is a small and feeble bone, placed on the outer side. They are often spoken of as the big bone and the little bone of the leg.

The **Tibia** is very broad and strong above, but becomes thinner as it descends. Its upper end is shaped into two oval depressions for receiving the two condyles of the femur. In front of the upper end (head) is a **tubercle** (fig. 53, *d*) to which the ligament passing to the patella is attached. The triangular **shaft** forms in front a sharp ridge, the **crest** of the tibia; on the inner side of this, the bone is uncovered by muscles, and may therefore be felt beneath the skin. On its outer side the tibia is connected with the fibula by an interosseous membrane, similar to that in the forearm. The outer and posterior surfaces of the bone are entirely covered by the muscles passing to the foot. At the lower end of the bone the inner side is marked by a triangular process, projecting downwards over the ankle-joint; this is the **internal malleolus.**

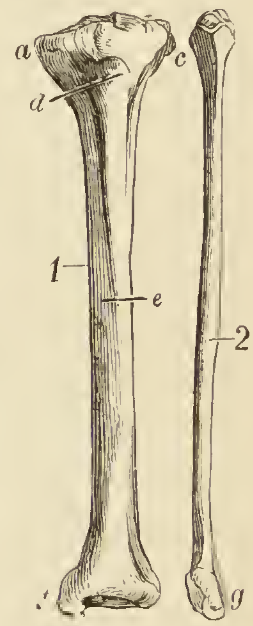


Fig. 54. — The Bones of the Leg, left side.

1, Tibia; 2, fibula; *a*, inner tuberosity; *c*, outer tuberosity of tibia and head of fibula; *d*, tubercle of tibia; *e*, crest of tibia; *f*, internal malleolus; *g*, external malleolus.

The **Fibula**, the lesser and outer bone (sometimes erroneously spoken of as the "splint" or "splinter bone"), takes no part in the formation of the knee-joint. At the ankle-joint, however, it descends below the level of the tibia, and thus overhangs and protects the joint; the projecting lower end is called the **external malleolus.** Behind

this process run the tendons of the peroneal muscles as they pass into the foot.

The Foot.—The bones of the foot, like those of the hand, may be tabulated in the following way:—

Ankle bones or Tarsus,	7
Metatarsals,	5
3 Phalanges in each small toe,	12
2 Phalanges in big toe,	2
	26

Tarsus.—The tarsal bones are larger, stronger, and more irregular in shape than those of the hand. They are as follows:—

Astragalus.
Os Calcis. Scaphoid.
(**Outer**) Cuboid. Three Cuneiform (**Inner**).

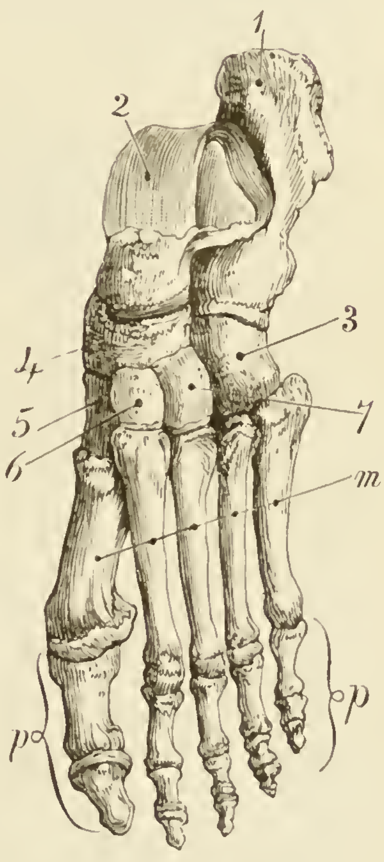


Fig. 55.—The Foot.

1, Os calcis; 2, astragalus; 3, cuboid; 4, scaphoid; 5, internal cuneiform; 6, middle cuneiform; 7, external cuneiform; *m*, metatarsal bones; *pp*, phalanges.

The **Astragalus** is the bone which articulates with the tibia in the formation of the ankle-joint. On the inner side it articulates with the inner malleolus, on the outer with the outer malleolus (fibula), below with the os calcis, and in front with the scaphoid.

The **Os Calcis** or heel-bone is the largest of the bones of the tarsus; it is easily recognized by the large process (**posterior tuberosity**) which forms the projection of the heel, and gives attachment to the great tendon of the calf-muscles, the **tendo Achillis**. On its under side the os calcis gives attachment to the muscles of the sole of the foot. The inner surface is marked by a smooth hollow in which lie the tendons, vessels, and nerves passing from the leg to the sole of the foot. By its anterior extremity this bone articulates with the cuboid.

The **Scaphoid** (boat-shaped) is placed immediately in front

of the astragalus, and rests on that bone. In its turn it supports the three cuneiform bones.

The **Cuneiform bones** are so named because each is shaped like a wedge. The two outer have the base of the wedge directed upwards and the apex downwards, but the internal cuneiform has the base downwards and apex upwards. They support the three inner metatarsal bones, and are the chief means by which the transverse arch of the foot is maintained.

The **Cuboid bone** (irregularly cubical) is placed on the outer edge of the foot, between the os calcis and the metatarsus. It is grooved on its outer edge and under surface for the tendon of the peroneus longus muscle, and it supports the two outer metatarsal bones.

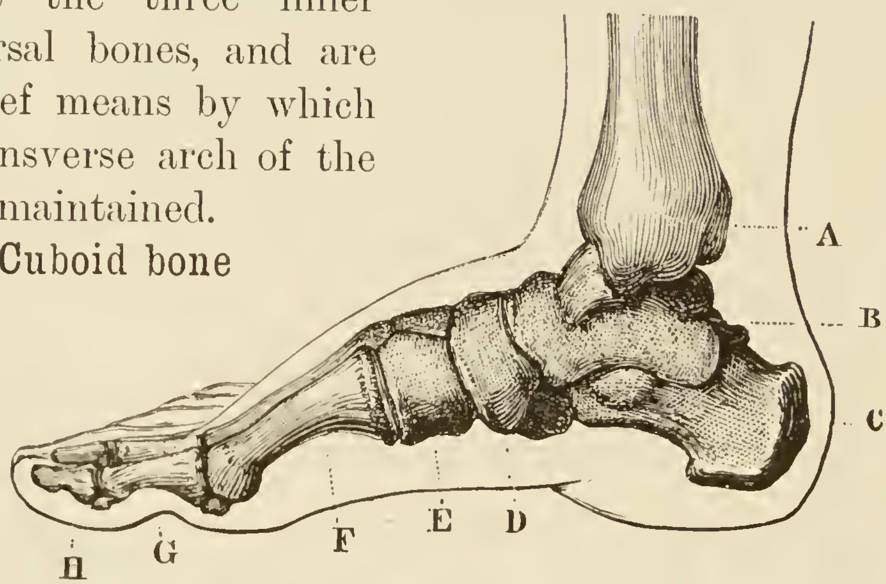


Fig. 56.—The Foot, from the side.

A, Tibia; B, astragalus; C, os calcis; D, scaphoid; E, internal cuneiform; F, metatarsal bone of great toe; G, H, phalanges of great toe.

The **Metatarsal bones** are longer and more slender than the metacarpal; the bone of the big toe is much thicker than either of the others, but it cannot be moved away from its fellows as the corresponding bone of the thumb can. The bone of the little toe has at its base a large triangular projection or **tuberosity**, which has attached to it the peroneus longus and tertius muscles.

The **Phalanges** of the foot are very small and insignificant as compared with those of the hand; the middle phalanx is the smallest, and is generally as broad as it is long. The two phalanges of the big toe are both large, and the terminal one has a very marked crest for the toe nail.

ARTHROLOGY.

THE DESCRIPTION OF THE JOINTS.

A **joint** or **articulation** is the union of two bones by means of some intervening substance or tissue. When the connection takes place only by a small quantity of connective tissue the union is so close that movement is impossible, and then we have a fixed joint, called **synarthrosis.** At other times the bones are united by a layer of fibro-cartilage sufficiently thick and elastic to allow of a limited movement between any two bones, but giving to a series of such articulations much freedom; this form is known as a yielding-joint or **amphi-arthrosis.** In all the joints of the limbs, however, there is a cavity interposed between the ends of the bones, and the latter are kept together by ligaments which close in the cavity and form a shut sac. This is a complete or **perfect joint**; it allows of much freedom of movement, and is called a **diarthrosis.**

The **structures** which assist in the formation of a joint are bone, cartilage or gristle, areolar tissue, adipose tissue, elastic tissue, fibrous tissue, synovial membrane. Besides these, the muscles also contribute to maintain the joint surfaces in their proper relation to each other, and bursal sacs ensure due and smooth movement. Another essential to the due action of the joints is the pressure of atmospheric air, and this is sufficient to keep the articular surfaces in contact even after all the muscles are removed.

The **ligaments** connecting the bones together are, for the most part, formed of strong bands of white fibrous tissue; in those joints which possess the freest movements they are arranged all round the joint so as to completely enclose the articular surfaces; these are called **capsular ligaments.** In some cases the ligaments are in the interior of the joint as

well as on the exterior; this is the case with the crucial ligaments of the knee, and the round ligament of the hip.

The **fixed** or **synarthrodial joints** include all the articulations of the bones of the skull and face excepting those of the lower jaw. In the tabular bones of the skull the union takes place by the edges of the bone being made rough and irregular, the projection of one bone fitting into a corresponding hollow in the other (**suture**). The arrangement is similar to what is called "dovetailing" in cabinet-making; and the irregularities are often more fantastic and wonderful than anything the art of man can produce.

The **amphi-arthrodial joints** are limited to the axial skeleton, and are seen in the union of the bodies of the vertebræ by the intervertebral substance, the union of the sacrum and coccyx, of the pieces of the sternum, of the two pubic bones, and of the sacrum with the innominate bones.

Movable or **diarthrodial joints** are, for the most part, situated in the limbs; under this head are included the whole of the joints familiar to people generally. Such as the shoulder, elbow, wrist, hip, knee, ankle, &c. These joints may be divided into four classes.

1. **Ball-and-socket** (enarthrodial).
2. **Hinge** .... (ginglymus).
3. **Pivot** ....(trochoidal).
4. **Gliding** ....(arthrodial).

Ball-and-socket Joints.—In these the end of one bone forms a rounded head which is received into a corresponding socket on the other bone. Such joints permit of free motion in almost every direction, but they are the most liable of all joints to become dislocated. The two characteristic joints of this kind are the shoulder and hip; the former of these has the most freedom of movement, in consequence of the glenoid cavity not limiting the rotation of the head of the humerus.

Hinge Joints.—In these the articular surfaces fit very accurately, and permit of movement only in one direction. The lateral ligaments are very strong, and dislocations are uncommon. Examples of this form are the elbow, ankle,

knee, wrist, and the joints between the phalanges of the fingers and toes.

Pivot Joints.—There are only two examples of this form of joint in the human body, viz. (1) the articulation of the atlas and axis, where the ring of the former turns on the pivot formed by the odontoid process of the latter, and (2) the upper joint between the radius and ulna, where the radius turns round in the ring formed by the orbicular ligament embracing its head and neck.

Gliding Joints.—These permit of a slight gliding movement of one bone on another. Such joints are those of the bones of the tarsus and carpus, the joints between the collar-bone and the breast-bone or blade-bone, and those of the articular processes of the vertebræ.

Movements of Joints.—The chief movements are the following:

1. **Angular movements**, by which the two parts of a limb form an angle with each other, or by which such angle is abolished. Movement which results in the limb being doubled up is called **flexion**; that which causes it to be straightened out is called **extension**. **Abduction** is the movement by which the limb is carried away from the middle line of the body, or the fingers or toes from the middle line of the hand or foot. **Adduction** is the reverse of this, the limb being drawn towards the middle line of the body, or of the hand or foot.

2. **Gliding** is the sliding to and fro of one articular surface on another, and exists to a greater or less extent in all joints; it is the only motion permitted in arthrodial joints, such as those between the bones of the carpus or tarsus.

3. **Coaptation** is the name given to the movement when different parts of a joint surface are used in succession, for the purpose of movement. This is seen in the movement of the knee-pan on the lower end of the thigh-bone.

4. **Circumduction** takes place in the ball-and-socket joints when the limb describes a cone, with the apex at the joint and the base at the end of the limb; such is the case when the arm is made to describe a circle.

5. **Rotation** is when the bone moves on its own axis.

In the forearm there is a form of movement which does not strictly come under either of these heads. In this movement the upper end of the radius rotates on its own axis in the ring of the orbicular ligament, but the lower end rotates on an axial line passing through the middle of the lower end of the ulna; the result is that the lower end of the radius passes across the front of the ulna while the upper end does not. When the hand moves inwards, so that the palm comes to be directed downwards (or backwards), the motion is called **pronation**; when it moves outwards, so that the palm comes to be directed upwards (or forwards), the act is called **supination.**

Hinge-joints have as a rule only the power of flexion and extension, ball-and-socket joints possess movement in all directions.

LIGAMENTS OF THE VERTEBRAL COLUMN.

Ligaments of the Bodies of the Vertebræ. — The bodies of the vertebræ are united by three connections: the intervertebral discs, the anterior common ligament, the posterior common ligament. The **intervertebral discs** are thick pieces of fibro-cartilage accurately fitting the opposed surfaces of the bodies of the vertebræ, and firmly uniting them. They are dense externally, but soft and pulpy in the centre; they are thickest in the lumbar region, and are deeper in front than behind in the cervical and lumbar regions. They take part in the production of the spinal curves, and it has been calculated that they form about one-fourth of the length of the vertebral column, exclusive of the sacrum and coccyx. The **anterior** and

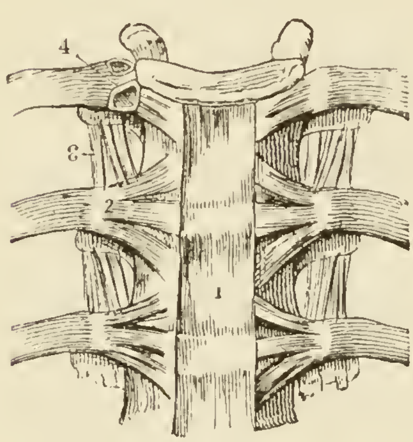


Fig. 57. — Ligaments of the Bodies of the Vertebræ and Heads of the Ribs.

1, Anterior common ligament; 2, ligament between the vertebral body and head of rib; 3, ligament between transverse process and tubercle of rib; 4, inter-articular ligament. [Wilson.]

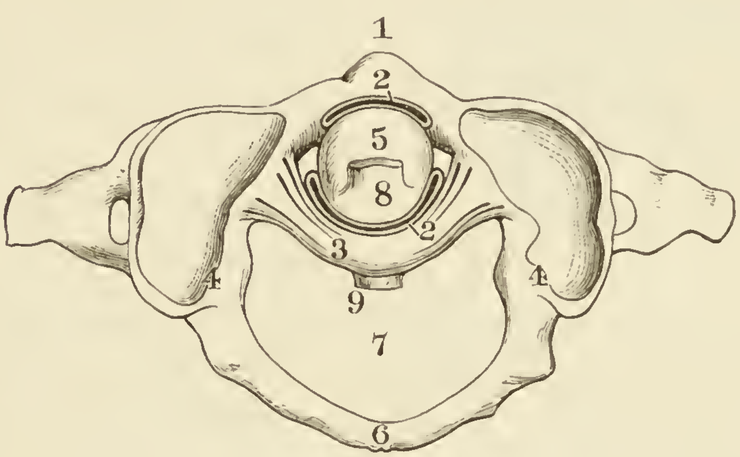
posterior common ligaments are strong bands of white fibrous tissue passing down the front and back of the vertebral bodies and intervertebral discs, and firmly connected with them, giving additional strength, and limiting motion.

Ligaments of the Laminæ.—The arches or laminæ of the vertebræ are connected by thin layers of ligament formed almost exclusively of yellow elastic tissue (**ligamenta subflava**). They assist in the maintenance of the erect posture, and so limit the expenditure of muscular force, and at the same time permit, by their elasticity, of the body being flexed.

The **Articular Processes** of the vertebræ are enclosed by

Fig. 58.—Articulation between Odontoid Process of Axis and Atlas.

1, Anterior tubercle of atlas; 2, anterior synovial cavity; 3, transverse ligament; 4, 4, articular facets for articulation with occipital; 5, odontoid process; 6, posterior arch; 7, vertebral canal; 8, check ligament; 9, vertical slip of transverse ligament.



ligaments which form a complete **capsule**, lined by a synovial membrane.

The **Spinous Processes** have thin membranes connecting them together, and a long band of considerable thickness runs along the tips of the spines from the last cervical vertebra to the coccyx (**inter-spinous** and **supra-spinous ligaments**).

The **Occipital bone, Atlas,** and **Axis** are connected by a special series of ligaments, of which the most important are a transverse band crossing the ring of the atlas to keep the odontoid process in place (**transverse ligament**), and **check ligaments** which pass from that process to the occipital bone and limit the rotation of the head. The upward and downward, or nodding movements of the head, take place between the atlas and occipital, the side-to-side or rotation movements between the atlas and axis.

ARTICULATIONS OF THE SKULL.

The whole of the articulations of the skull, excepting that of the lower jaw with the temporal bone, are examples of synarthrosis or fixed articulation. This form of connection in the skull is called a **suture**, and different varieties are described, such as the *serrated suture*, where the edges are much serrated; the *limbous suture*, in which overlapping is the prominent feature; and the *harmonic suture*, where the union is obtained by the accurate fitting of minute irregularities. In all sutures there is a small quantity of connective tissue between the bones, but their security depends less upon this than on the fitting of the edges of the bone.

Fig. 59.—Articulation of Lower Jaw.

1, Glenoid cavity; 2, articular eminence; 3, fibro-cartilage; 4 and 5, synovial cavities; 6, the fibro-cartilage removed from the joint. [Wilson.]

The chief sutures of the skull are as follows:—

The **Coronal suture** crosses the front part of the head, and unites the frontal bone with the anterior margin of the two parietal bones.

The **Sagittal suture** runs in the middle line of the vertex, between the two parietal bones.

The **Squamous suture** on each side is formed by the squamous part of the temporal bone overlapping the lower edge of the parietal.

The **Lambdoidal** (like the Greek letter *lambda*) **suture** crosses the back of the head, and connects the occipital and the back part of the two parietal bones.

The **Transverse suture** crosses the upper part of the face at the level of the orbits, and marks the line of union of the bones of the face and those of the cranium.

Numerous other sutures connect the bones of the skull and the bones of the face, but they are not of sufficient importance to justify a fuller description here.

Joint of the Lower Jaw.—This is the joint between the

condyle of the lower jaw and the glenoid cavity of the temporal bone. The joint-cavities are enclosed by a **capsular ligament**, the outer fibres of which are thick and strong, and often described separately as the **external lateral ligament**. In the middle of the joint is a thick pad of **fibro-cartilage**, dividing it into two cavities each lined by a synovial membrane. When the mouth is opened, both the condyle and the fibro-cartilage travel forward on the articular eminence of the temporal bone, and again glide back when the mouth is shut. Side-to-side movement also takes place in the same way.

LIGAMENTS OF THE RIBS, AND OF THE PELVIS.

Union of the Ribs and Vertebræ.—The ribs are united to the bodies of the vertebræ and also to the transverse processes, excepting the last two, which, being floating ribs, have no connection with the transverse processes. As a rule, the head of each rib is connected with two vertebræ (fig. 57) and with the intervertebral substance between them, and there are two synovial cavities. The tubercle of the rib rests on the tip of the transverse process of the lower of the two vertebræ and is connected with it by strong ligamentous bands, some of them forming a capsule and enclosing a synovial membrane.

The **Costal Cartilages** are joined to the breast-bone by numerous bands in front and behind, and similar bands unite the several pieces of the sternum itself.

Ligaments of the Pelvis.—The innominate bone is united to the side of the sacrum by a joint known as the **sacro-iliac synchondrosis**. In large part this union takes place by means of a plate of cartilage placed between the two bones, but there are also in front scattered fibrous bands, and behind very strong and thick ligaments uniting them.

Between the **sacrum** and **ischium** are two thick, strong, and large ligamentous bands, the **greater** and **lesser sacro-sciatic ligaments**. The **greater**, placed behind the lesser, stretches across from the side of the coccyx, sacrum, and back of ilium

to the back edge of the tuberosity of the ischium. The **lesser** ligament runs from the side of the sacrum to the tip of the spine of the ischium. These two ligaments convert the notches at the back of the innominate bone into two holes, the **greater** and **lesser ischiatic foramina.**

The **pubic bones** are joined together by ligamentous bands, an interosseous fibro-cartilage being interposed.

The **obturator foramen** is filled up by a thin but strong

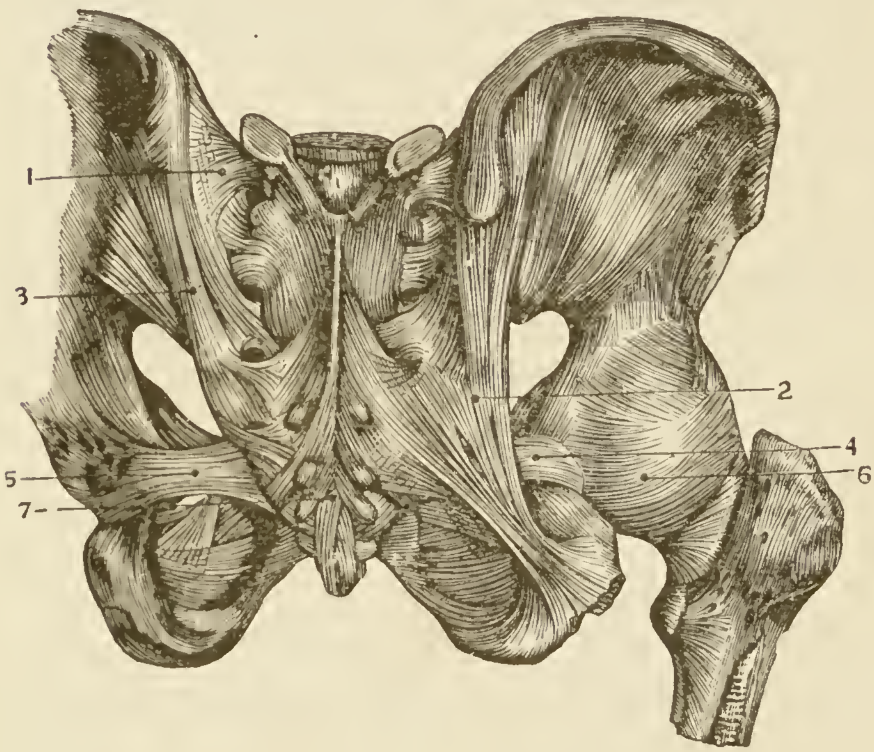


Fig. 60.—Ligaments of the Pelvis and Hip-joint.

1, Posterior sacro-iliac ligament; 2, great sacro-sciatic ligament; 3, posterior sacro-iliac ligament; 4, lesser sacro-sciatic ligament; 5, the same, exposed by the removal of the greater ligament; 6, back of capsule of hip-joint; 7, sacro-coccygeal ligament. [Heath.]

membrane, excepting at the upper part, where the vessels and nerve pass through.

LIGAMENTS OF THE UPPER LIMB.

Joint between the Collar-bone and Breast-bone.—This is called the **sterno-clavicular articulation.** The joint is a double one, there being two synovial cavities separated by an interarticular fibro-cartilage. The ligamentous bands form a capsule, thickest in front and above, thinner behind, and very short below. An important band also connects the inner ends of the two collar-bones. Movement takes place forwards, backwards, upwards, and downwards, and there is also circumduction.

The outer end of the collar-bone is connected with the acromion process of the blade-bone in much the same way, there being two synovial membranes enclosed by a capsule, and often an interarticular fibro-cartilage.

Movements of the Scapula.—The scapula has a considerable degree of mobility, the movement taking place in forward, backward, upward, and downward directions. It is unable to move away from the chest wall, being held down by muscles. The freedom of movement of the scapula adds greatly to the play of the arm, so that even when the shoulder-joint is stiff the arm is still able to move.

Shoulder-joint.—This is the most perfect ball-and-socket joint in the body, and enjoys greater freedom of movement than any other joint. On bringing the head of the humerus and the glenoid cavity of the scapula together, it will be noticed that the cavity is much too small for the head; this defect is to some extent obviated by the glenoid cavity being surrounded by a band of fibro-cartilage (**glenoid ligament**), which at the same time enlarges and deepens the cavity. Notwithstanding this, however, the head still remains large in proportion to the cavity, and this accounts for the very free movement the joint possesses, and also for its liability to become dislocated.

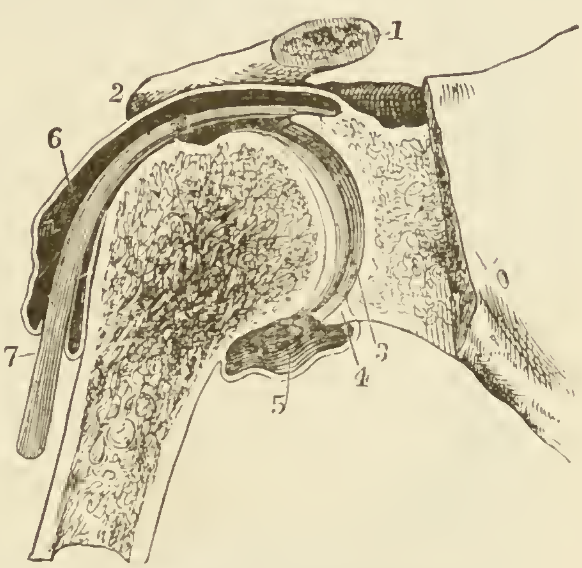


Fig. 61.—Section through Shoulder-joint.

1, Clavicle; 2, acromion; 3, glenoid cavity; 4, glenoid ligament; 5, capsule; 6, synovial membrane on biceps tendon; 7, tendon of biceps. [Wilson.]

The chief ligament of the joint is the **capsular ligament**, which entirely surrounds the articular surfaces and forms a shut sac. The fibres of the capsule are long and loose, so that they are not effective in keeping the articular surfaces in contact; that is performed by the external pressure of atmospheric air, but for this to be possible the capsule must be intact. The capsule also serves to support the synovial mem-

brane which lines it, and it limits the movements of the joint in the several directions.

The **synovial membrane** is extensive, and generally communicates with one or more bursal sacs placed beneath the muscles.

Several muscles are in direct contact with the capsule and give it very necessary support, one of them (the subscapularis) actually takes the place of the capsule; the long tendon of the biceps goes through the upper part of the joint, to be attached to the upper edge of the glenoid cavity and to the glenoid ligament.

Movements.—The shoulder-joint has every variety of movement; namely, movement forwards and backwards, abduction, adduction, rotation, and circumduction.

Elbow-joint.—This is one of the best examples of a ginglymus or hinge-joint. The bones taking part in its formation are the lower end of the humerus, the sigmoid cavity of the ulna, and the cup-shaped depression at the upper end of the radius.

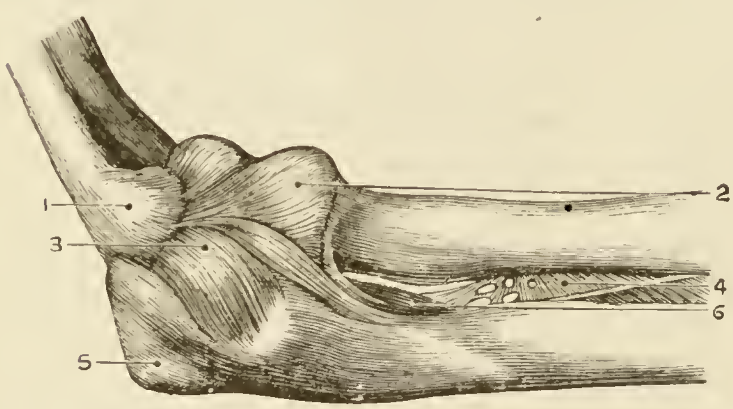


Fig. 62.—1, Internal condyle of humerus; 2, anterior ligament; 3, internal lateral ligament; 4, interosseous membrane; 5, olecranon; 6, ulna. [Heath.]

The chief ligaments are two strong and short **lateral ligaments**, which, unlike those of the shoulder, do actually keep the joint-surfaces in contact as well as limit the movements; these are called the **external** and **internal lateral ligaments**. There are also very loose **anterior** and **posterior ligaments**, which serve to make the joint-cavity a closed sac, and limit the movements, the former limiting extension and the latter flexion.

In front of the joint is the coronoid process of the ulna, and behind it the olecranon, and these serve to limit movement, if the anterior and posterior ligaments are insufficient; the coronoid then limits flexion and the olecranon extension.

The **synovial cavity** is extensive, and not only lies between the humerus and bones of the forearm, but also serves for the upper articulation between the radius and ulna.

Movements.—Flexion and extension.

Connections between the Radius and Ulna.—There are three connections between these bones; namely, upper, middle, and lower.

The **upper connection** consists of the **orbicular ligament**, a firm band which is attached to the outer side of the ulna, and forms a ring in which the head of the radius rotates.

The **middle connection** is a membrane, the **interosseous membrane**, passing from the inner edge of the radius to the outer edge of the ulna. It forms a long hinge, by means of which the radius moves upon the ulna; it also serves to separate the muscles on the front from those on the back of the forearm, and to give attachment to those muscles.

Fig. 63. — Upper End of Ulna, to shew Orbicular Ligament.

1, Olecranon; 2, coronoid process; 3, orbicular ligament which surrounds the neck of the radius. [Wilson.]

The **lower attachment** is in the form of strong but rather loose bands, connecting the lower end of the radius and ulna.

Movements.—The movements between these bones have been already described (p. 62), and consist of *pronation* and *supination*. In both the radius moves upon the ulna, but the lower end of the latter bone also moves (though in a very slight degree) in a direction opposite to the movement of the radius.

Wrist-joint.—The joint between the bones of the forearm and the first row of bones of the wrist is a modification of the ginglymus or hinge-joint. The ligaments are anterior, posterior, and two lateral. The movements consist of flexion, extension, abduction, adduction, and a combination of these resulting in a spurious circumduction.

Between the bones of the wrist (carpal bones) the joints are arthrodial or gliding joints; the ligaments are very numerous and complicated, and include, in addition to bands of fibres on the front and back and at the sides of the hand, very strong and short **interosseous ligaments** placed between the bones. The synovial cavities are numerous and complicated, and the mechanism is such that anatomists have entered into interminable discussions thereon, without arriving at any agreement. It may, however, be pointed out that the capacity of the hand for grasping small objects depends on its being formed of many small bones, which are capable of changing their position in relation to each other.

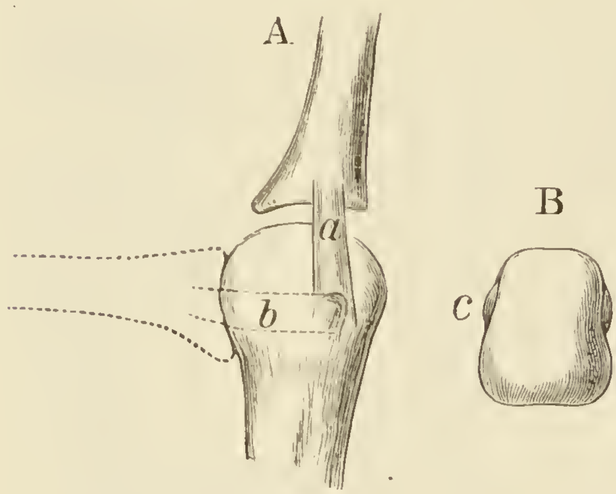


Fig. 64.—Articulation of Phalanges.

A, The articulation and its lateral ligament; B, head of the metacarpal bone. *a*, Lateral ligament when the joint is extended; *b*, the same ligament when the joint is flexed; *c*, tubercle to which the lateral ligament is attached. [Cleland.]

The **joints between the metacarpal bones and phalanges** are noteworthy, because of a peculiar effect which the shape of the articular surfaces has in limiting the movements. It is a familiar fact that while the fingers can be easily separated from each other (or abducted) when the hand is extended, they cannot be so separated when the hand is flexed. The explanation of this fact is as follows. The heads of the metacarpal bones (familiarly known as the *knuckles*) have a larger measurement from before backwards than from above downwards. It happens, therefore, that when the fingers are straight the lateral ligaments are loose, and lateral movement can consequently take place; but when the hand is bent the phalanx is carried forwards into the long diameter of the knuckle, the lateral ligaments become tight, and lateral movement is impossible (*Cleland*).

The articulations between the **phalanges of the fingers** are

true ginglymus or hinge-joints, enjoying only flexion and extension, and not permitting of the slightest amount of lateral motion. Their ligaments are two strong bands of lateral fibres (**lateral ligaments**), a fibro-cartilaginous **anterior ligament** and no posterior ligament, the place of the latter being taken by the extensor tendon of the fingers.

LIGAMENTS OF THE LOWER LIMB.

Hip-joint.—This joint closely resembles the shoulder, and, like it, is a ball-and-socket joint. The difference between them consists (1) in the acetabulum being deeper and more accurately fitted to the head of the bone, so that the cavity encloses a little more than half the head: (2) in there being a ligament in the interior of the hip-joint (the **ligamentum teres**), which is wanting in the shoulder; and (3) in the large muscular process, the great trochanter, considerably limiting the range of movement of the hip as compared with the shoulder.

Deep as the cavity of the acetabulum is in the bone itself, it is still further deepened by a ring of fibro-cartilage which runs round it, and is called the **cotyloid ligament**.

The chief ligament is the **capsular ligament**, which is attached above to a little outside the rim of the acetabulum, and below passes on to the neck of the thigh-bone. In front the capsule covers the whole neck of the femur; but behind it is limited to the half next the head, the rest of it being uncovered. When the neck of the bone gets broken close up to the head, the fracture is entirely within the capsule, and the injury is described as an **intra-capsular fracture**.

The **ligamentum teres** (round ligament) is situated in the interior of the joint, and is attached by one end to the little depression on the head of the femur, and by the other to the inner side of the acetabulum.

Many muscles lie in contact with the capsule, and are consequently denominated **capsular muscles** They give support to the joint, and ensure the joint surfaces being kept in their proper relation to each other.

Several large bursæ are situated around the hip-joint, and one of these lying between the tendon of the ilio-psoas muscle and the capsule often communicates with the cavity of the joint.

The **synovial cavity** is large, and the synovial membrane forms a tube round the ligamentum teres.

The **movements of the joint** are flexion, extension, abduction, adduction, circumduction, and rotation.

Knee-joint.—The knee is the largest joint in the body. It is a ginglymus or hinge-joint, and comprises the articulation of the tibia with the femur and of the patella or knee-cap with the femur.

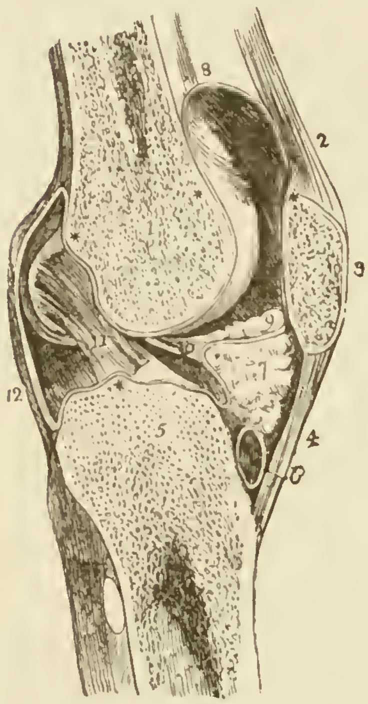


Fig. 65.—Section through Knee-joint.

1, Femur; 2, tendon of extensor muscle; 3, patella; 4, ligamentum patellæ; 5, tibia; 6, bursa; 7, pad of fat; 8, synovial pouch: 9, 10, synovial fringes; 11, anterior crucial ligament. 12, Posterior ligament. [Wilson.]

In front the joint is covered by the patella, the ligament which attaches that bone to the tibia, and the expanded tendons of insertion of the quadriceps extensor muscle, as well as by some accessory fibres often described as the **capsular ligament**. Behind, it has a broad expansion of ligamentous fibres forming the **posterior ligament**, derived mainly from the tendon of the semimembranosus muscle, but in part also from the origins of the gastrocnemius. On each side is a strong **lateral ligament**, the inner one being spread out and large, the outer cord-like and much smaller. The inner is in direct contact with the synovial membrane lining the joint; the outer is not so.

When the joint is laid open it is found that the strongest ligaments are in the interior. These are found as two strong bands situated in the notch at the back of the lower end of the femur, and connected below with the rough surface at the upper end of the tibia. From the fact that they cross each other in passing to their destination, they are called the **crucial ligaments.**

Lying on the upper surface of the tibia are two bands of fibro-cartilage (the **semilunar cartilages**), each of which is thick at the outer edge and very thin at the inner. They are attached by their ends to the rough middle part of the upper end of the tibia, close to the crucial ligaments; the outer encloses a circular area, and the inner an oval one. The cartilages are also connected with the outer edge of the articular area of the tibia by fibrous bands, in such a way as to admit of their sliding to a limited degree backwards and forwards. In this way they form a sliding or shifting socket, on which the condyles of the femur move in the flexion and extension of the joint.

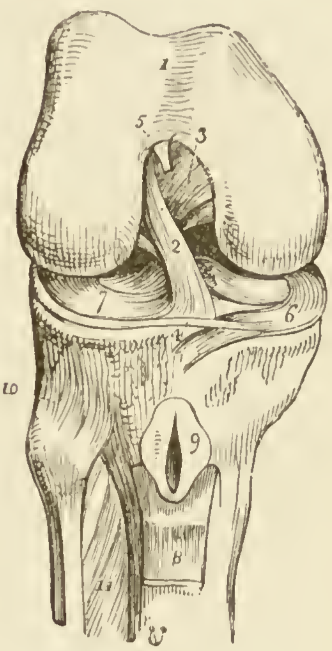


Fig. 66.—Knee-joint.

1, Surface of femur on which patella rests; 2, anterior crucial ligament; 3, posterior crucial ligament; 4, ligament connecting the two semilunar cartilages; 5, part of synovial fringe; 6 and 7, semilunar cartilages; 8, ligamentum patellæ (turned down); 9, bursa; 10, ligament connecting tibia and fibula; 11, interosseous membrane. [Wilson.]

The patella is coated on its back surface by cartilage, and forms part of the front wall of the cavity of the joint. When the leg is extended or flexed it slides on the lower end of the femur, being drawn up by the quadriceps muscle which is inserted into it.

The **synovial membrane** of the knee is the most extensive in the body. It passes upwards beneath the exterior muscles to a point fully two a half inches above the upper margin of the patella when the leg is extended. It encloses and surrounds the crucial ligaments, and lines the other ligaments of the joint, excepting the external lateral. Just beneath the patella there is situated a large pad of fat, covered by synovial membrane; this serves in certain positions of the joint to fill up the hollow at the lower end of the femur, and it is connected with that notch by a considerable synovial fold, which sometimes becomes of surgical interest from its being torn or displaced.

Movements.—The knee-joint is one of the strongest of the

articulations of the body, while, at the same time, it admits of the most perfect degree of movement in the direction of flexion and extension. When it is half-flexed it allows of inward and outward rotation of the tibia upon the femur.

There are many **bursæ** in the neighbourhood of the knee, the one most frequently troublesome is that lying on the front of the knee-cap, which when enlarged or inflamed produces the condition known as "housemaid's knee".

Connections between the Tibia and Fibula.—Like those of the radius and ulna, these connections may be divided into upper, middle, and lower.

The **upper connection** consists of fibres uniting the upper end of the fibula with the under part of the outer tuberosity of the tibia. This joint has a synovial cavity, which sometimes (though rarely) communicates with the knee-joint.

The **middle connection** is formed by an **interosseous membrane** joining the bones together. It is similar to that described as uniting the radius and ulna, and serves like purposes.

The **lower connection** is formed by an **anterior**, a **posterior**, and an **interosseous** band of fibres conecting the lower end of the tibia and fibula. The last of these (the interosseous) is one of the strongest ligaments in the body, and when strain is put on the union the fibula breaks a hundred times to once that the ligament gives way.

The connection between these bones is such as to allow of very slight movement of the small bone upon the large one, and but for this, fracture of the fibula would be even commoner than it is. There is, however, no free movement such as takes place between the radius and ulna.

Ankle-joint.—This is a ginglymus or hinge-joint formed by the articulation of the lower end of the tibia and fibula with the upper surface of the astragalus. As in all hinge-joints, the **lateral ligaments** are the most important, and form the hinges on which the joint moves. The internal ligament is triangular in shape (**deltoid**), and is very thick and strong; the external is in three strong cord-like bands. The **anterior** and **posterior**

ligaments are mere scattered bands, which serve to make the joint a closed cavity and support the synovial membrane.

When the upper surface of the astragalus and the lower articular surface of the tibia and fibula are examined, it will be observed that they both have the peculiarity of being wider in front than behind. When, therefore, the foot is at right angles to the leg these surfaces exactly fit, and no lateral movement is possible; but when the foot is extended the narrow part of the astragalus comes to lie against the wide part of the tibia, and considerable lateral movement can then take place. The only other peculiarity of this joint is, that both flexion and extension are much more limited than in the knee, elbow, or wrist.

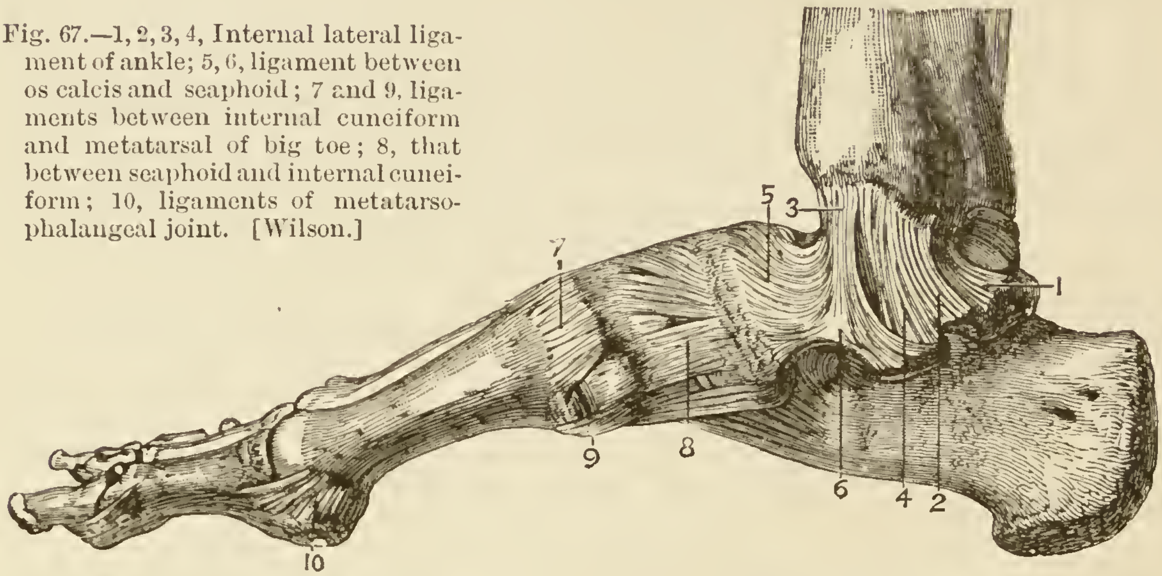
Joints of the Foot.—The only peculiarity in the connection between the astragalus and os calcis is the presence of a thick and strong **interosseous ligament**, placed in a cavity formed by the grooved upper surface of the os calcis and lower surface of the astragalus. This forms a sort of pivot on which the bones move, so that their motion is a limited rotatory gliding.

The bones of the tarsus are held together by numerous ligaments passing from one to another on the upper and under surfaces, but too complicated to justify any extended description. There are, however, two strong bands on the under surface of the foot which need special mention, as being the chief means by which the arches of the foot are maintained, they are the **long** and the **short plantar ligaments.** They connect the under surface of the os calcis and cuboid.

Arches of the Foot.—As usually described there are three arches in the foot, two of which are longitudinal and the third is transverse. The outer longitudinal arch is formed by the os calcis, cuboid and two outer metatarsal bones; it is only very slightly raised. The inner longitudinal arch is formed by the os calcis, astragalus, scaphoid, cuneiform, and three metatarsal bones; it is at its highest point raised about 1½ inches from the ground. The transverse arch is formed by the cuboid and three cuneiform bones. It is usually very distinct,

but is higher at its inner end than at its outer. The arches are due (1) to the shape and disposition of the bones, (2) to the

Fig. 67.—1, 2, 3, 4, Internal lateral ligament of ankle; 5, 6, ligament between os calcis and scaphoid; 7 and 9, ligaments between internal cuneiform and metatarsal of big toe; 8, that between scaphoid and internal cuneiform; 10, ligaments of metatarso-phalangeal joint. [Wilson.]



tension of the ligaments, and (3) to the muscles and fasciæ in the sole of the foot.

The **ligaments and joints of the metatarsus and phalanges of the foot** correspond in nearly every particular with those of the metacarpus and phalanges of the hand, the chief difference being that the big toe is not so free in its movements as the thumb, and that it is set parallel with the other toes instead of at an angle to them.

MYOLOGY.

THE DESCRIPTION OF THE MUSCLES.

The fibres of striped muscle have been already described (p. 21), and it has been mentioned that they are gathered into bundles called fasciculi, and these are aggregated to form muscles. Each muscle so formed is contained in a sheath made of fibrous tissue with some admixture of elastic fibres, and terminates at each end in a white glistening cord or membrane, formed also of fibrous tissue, and called a **tendon.** Muscles vary greatly in their shape and in the disposition of the fibres in relation to the tendon. Sometimes the fibres run longitudinally, and the muscle is thickest in the centre so as to be **fusiform,** in other cases they are spread out like a fan, the fibres converging to a common tendon, constituting a **radiate** muscle. Again, they are **penniform,** arranged like the barbs of a quill-pen on one side of a tendon, or **bi-penniform,** like the barbs of a feather on both sides of a central tendon.

We speak of the most fixed attachment of a muscle as the **origin,** and the most movable end is called the **insertion.** When both ends are equally movable we give the term origin to the attachment nearest the middle line, and insertion to that farthest from the middle line.

The muscles are separated from each other by sheets of fibrous tissue called **fasciæ,** and frequently these sheets also form a means of attachment of the muscles. Beneath the skin the fascia has a considerable admixture of fat, and contains the superficial veins and nerves; it is known as the **superficial fascia.** Beneath this is a stronger and more compact membrane, supporting the muscles, forming sheaths for the vessels, and becoming firmly attached to ridges and prominences on the bones; this is the **deep fascia.** The superficial fascia forms a continuous sheet over the whole body, but the deep fascia of each region is more or less definitely restricted to that region

by its bony attachments. Hence matter or other fluid formed beneath the deep fascia is retained by these connections. The strongest and thickest fascia is that which envelopes the muscles of the thigh, and is known as the **fascia lata** (*latus*, broad).

Muscles of the Head and Neck.—The muscles of the cranium and face are known as the *muscles of expression*, from the fact that they are brought into play in the facial expression of grief, anger, pleasure, pain, surprise, astonishment, &c.

These muscles are all very thin and of a pale tint; they lie for the most part immediately beneath the skin, and are so intimately connected with it as to produce, when in action, the ridges and furrows we notice in the face in the expression of strong emotions. The fibres of neighbouring muscles form numerous communications, and it is therefore difficult (especially in the face) to define the limits of each muscle; and the part played by a given muscle in producing the expression characteristic of any emotion is also by no means easy to ascertain.

The muscles of expression have been named in some instances from their shape, but more frequently from their action, the result being that, where a muscle has more than one action, it obtains a Latin name long enough to appal a tyro; of which fact the levator labii superioris alæque nasi (elevator of the upper lip and ala of the nose) may be taken as a trite example.

None of the muscles are of sufficient importance to require a full description; we shall, therefore, simply name some of the chief of them.

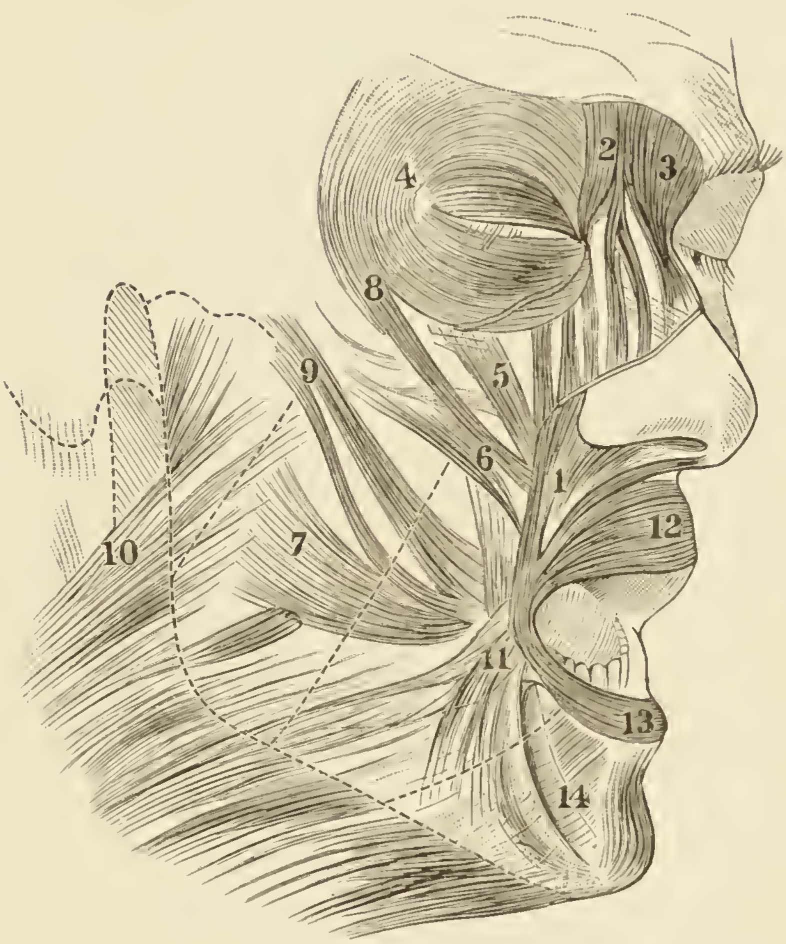
Covering the bones of the skull is a thin, spread-out tendon (**aponeurosis**), with which two fleshy muscular masses are attached in front and two behind. This apparatus is known as the **occipito-frontalis** muscle; it is brought into action in drawing up the eyebrows, as in astonishment, surprise, and terror, and in many persons produces a forward and backward movement of the scalp.

Round each eye is a wide, but thin, circle of muscular fibres,

the **orbicularis palpebrarum** muscle; by means of those fibres, which lie on the eyelids, the eyes are closed, while the outer mass (much the thicker) causes the drawing down of the eyebrows in thought, doubt, and ill-temper. Accessory bands of fibres, called the **corrugatores supercilii** (contractors of the eyebrows), aid the orbicularis muscles, and are especially effec-

Fig. 68.—Muscles of Face.

1, Elevator of upper lip and ala of nose; 2, descending slip of occipito-frontalis; 3, pyramidal muscle of nose; 4, orbicularis palpebrarum; 5, elevator of upper lip; 6, elevator of angle of mouth; 7, risorius; 8, lesser zygomatic; 9, greater zygomatic; 10, platysma myoides; 11, depressor of angle of mouth; 12 and 13, orbicularis oris; 14, depressor of lower lip. [Henle, modified.]



tive in drawing the eyebrows towards each other and producing vertical wrinkles above the bridge of the nose.

Other muscles pass to the angles of the mouth. The outer of these is called **zygomaticus**, because it springs from the zygomatic part of the malar bone; it effects the drawing up of the corner of the mouth in laughter. A little nearer the nose is the **special elevator of the angle of the mouth**; next comes the **elevator of the upper lip**, which (as Darwin has shown) when in action exposes the canine tooth, and is brought into play in sarcasm and irony; and then the **elevator of the upper lip and ala of the nose**, already mentioned, which is used in the expression of disgust.

Round the mouth is a circular mass of muscle, the **orbicularis oris**, in which the fibres of the muscles just described terminate. In the lower lip the chief muscles on each side are the **depressor of the angle of the mouth**, the **depressor of the lower lip**, and a thin sheet of muscle which is continued up from the neck to the angle of the mouth, and is called the **risorius** muscle. The orbicularis oris is used in pursing up the mouth and in pouting; the muscles of the lower lip are used in expressing pain, discontent, sorrow, &c.

All the muscles of expression obtain their nerve supply from the facial or 7th cranial nerve.

Muscles of Mastication.—This group consists of five muscles on each side of the head, of considerable strength, having their insertion into the ramus of the lower jaw and the processes given off from it; these are the temporal, masseter, external pterygoid, internal pterygoid, and buccinator.

The **Temporal** (as its name shows) is placed at the *temple*, and fills up the hollow at the side of the head noticeable in the bony skull; it is fan-shaped, and ends in a strong tendon inserted into the coronoid process of the lower jaw.

The **Masseter** muscle covers the outer surface of the ramus of the lower jaw, and is attached above to the malar bone and zygoma of the temporal.

These two muscles are the chief means by which the teeth of the lower jaw are brought against those of the upper in masticating food.

The **Pterygoid** muscles are so called from their attachment to the pterygoid plate of the sphenoid bone. The **external pterygoid** muscle passes almost horizontally outwards, to be fixed to the inner surface of the neck of the condyle of the lower jaw; the **internal pterygoid** runs downwards and outwards, to be inserted into the inner side of the angle of the same bone. Like the previous muscles, they assist in closing the mouth, and bringing the two ranges of teeth in contact, but in addition, the pterygoids move the jaw from side to side, so that the four muscles named (two pterygoids, temporal, and masseter) combine a scissors movement of the lower jaw

with an antero-posterior and lateral motion, such as is effective in grinding the food by means of the molar teeth.

The **Buccinator** muscle forms the greater part of the mass of the cheek, and in front is intimately blended with the orbicularis oris. It is the "feeder muscle", serving to push the

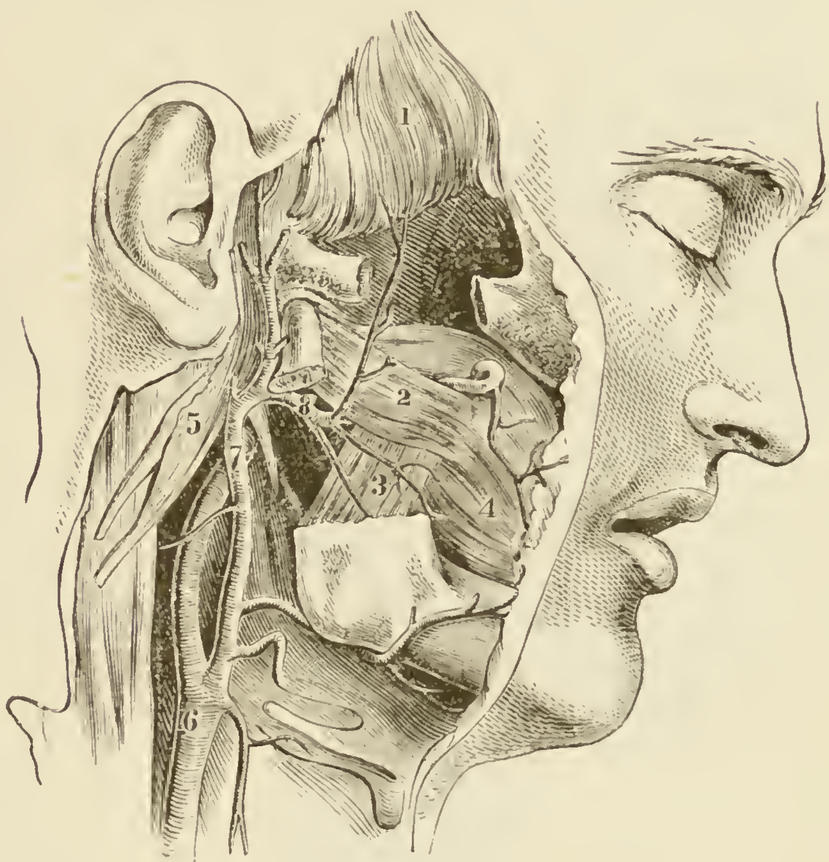


Fig. 69.—Muscles and Vessels of the Pterygoid Region.

1, Temporal muscle (turned up); 2, external pterygoid; 3, internal pterygoid; 4, buccinator; 5, digastric and stylohyoid muscles (turned back); 6, common carotid artery; 7, external carotid; 8, internal maxillary artery. [Ellis.]

food between the teeth on the outside as the tongue does on the inside of their range.

The muscles of mastication get their nerve-supply from the inferior division of the 5th cranial nerve, excepting the buccinator which is supplied as a muscle of expression by the facial.

Muscles of the Eye-socket (Orbit).—The eye is closed (as has been already mentioned) by the orbicularis palpebrarum; it is opened by a muscle coming from the back part of the orbital cavity and passing to the upper edge of the upper lid, the **levator palpebræ** (elevator of the eyelid). The other muscles of the orbit move the eyeball. Four of them pass in a straight course from their origin at the back of the orbit to the front of the eyeball, and hence are called **recti** muscles (*rectus*, straight). They move the eyeball outwards (**rectus**

externus), inwards (r. **internus**), upwards (r. **superior**), downwards (r. **inferior**). Two others pass obliquely to the eye, and terminate at the back part of the ball; these are the **superior** and **inferior oblique**.

Nerve Supply.—The muscles of the orbit are all supplied by the 3rd cranial nerve, excepting the external rectus (by the 6th) and the superior oblique (by the 4th).

Muscles of the Neck.—Passing obliquely across each side of the neck is a large and long muscle, named the **sterno-mastoid**; it passes from the upper end of the sternum and inner end of the clavicle to the temporal bone behind the ear. This muscle, when contracting, turns the head so that the face is directed slightly upwards and towards the opposite shoulder.

At the back of the neck a large muscle covers the deep muscular mass on each side; it is triangular in shape, the two together forming an irregular four-sided figure, and hence it is named **trapezius**. It is connected with the spines of the dorsal vertebræ, the occipital bone, the spine of the scapula, and the outer end of the clavicle.

Certain small ribbon-like muscles pass from the sternum and clavicle to the larynx (voice box) and hyoid bone, and are the means by which these structures are brought back to their place again, after having been raised in the action of swallowing. They are named from their connections, and are the **sterno-hyoid**, **sterno-thyroid**, **thyro-hyoid**, and **omo-hyoid**.

Beneath the jaw are several muscles whose action is to raise the hyoid bone in the act of swallowing. The most important of them is called **digastric**, from the fact that it has two fleshy bellies with a tendon between them (Gk. *dis*, twice, and *gaster*, a belly); its posterior connection is with the mastoid part of the temporal bone, and its anterior with the lower jaw near the symphysis. The tendon runs through a pulley formed of fascia, attached to the hyoid bone. When the mouth is shut the digastric draws up the hyoid bone, but when the latter is fixed it opens the mouth by pulling down the jaw.

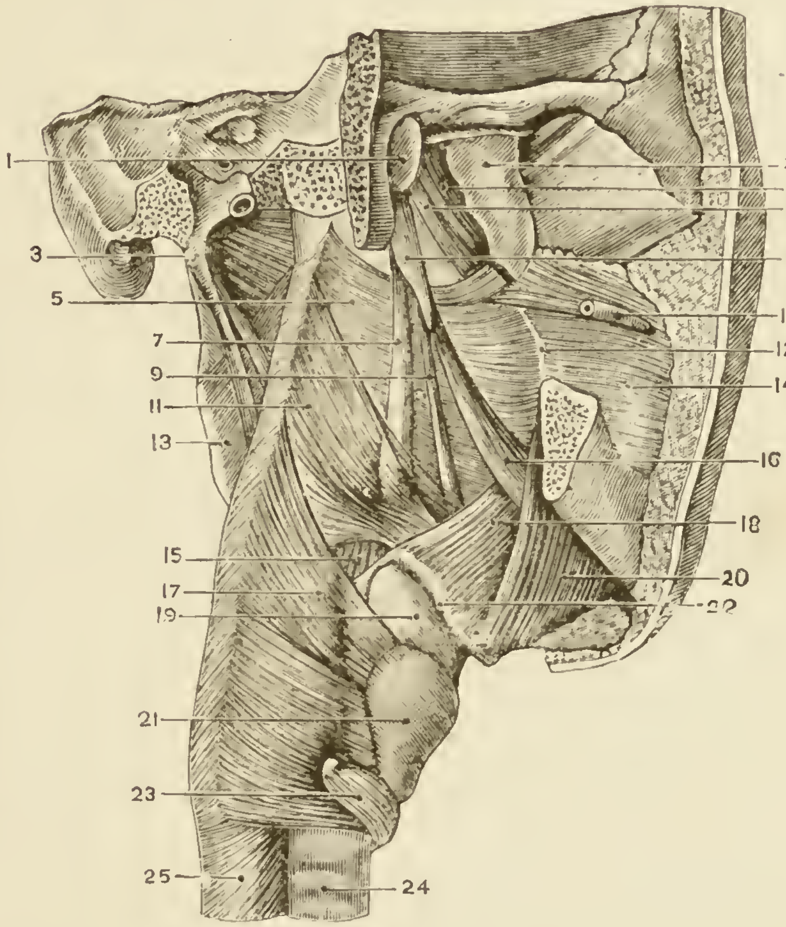
The **mylo-hyoid** is a flat muscle passing from the inner surface of the lower jaw to the hyoid bone, the muscles of the

two sides being intimately blended in the middle line. It forms the floor of the mouth, and supports the submaxillary and sublingual salivary glands. When in action it either raises the hyoid or depresses the lower jaw, according as the one or the other is free to move.

A small muscle called **genio-hyoid** also connects the hyoid and lower jaw and assists the mylo-hyoid in its action.

Fig. 70.—Side View of Pharynx.

1, Eustachian tube; 2, external pterygoid plate; 3, left styloid process; 4, tensor muscle of palate; 5, superior constrictor muscle of pharynx; 6, elevator of palate; 7, stylo-pharyngeus; 8, right styloid process; 9, stylo-hyoid muscle; 10, duct of parotid gland; 11, middle constrictor; 12, pterygo-maxillary ligament; 13, internal pterygoid muscle; 14, buccinator muscle; 15, stylo-pharyngeus (lower part); 16, stylo-glossus; 17, inferior constrictor; 18, hyo-glossus; 19, thyro-hyoid membrane; 20, mylo-hyoid muscle; 21, thyroid cartilage; 22, hyoid bone; 23, crico-thyroid muscle; 24, trachea; 25, gullet. [From Heath, after Sappey.]



The only other important muscles of the head and neck are those of the tongue, palate, and pharynx.

Muscles of the Tongue.—The tongue is itself mainly composed of muscular fibres, some of which run in its length, others transversely, and a third set vertically. The fibres are notable because they branch and communicate with each other, because they are mixed with a considerable quantity of fine fat, and because of their firm connection with the mucous membrane covering the tongue. Other muscles pass from the styloid process of the temporal bone, the hyoid bone, and lower jaw to the tongue. Their names are descriptive of their attach-

ment, viz. the **stylo-glossus** (*glossa*, the tongue), **hyo-glossus, genio-hyo-glossus** (*genion*, the chin), and **palato-glossus.**

Muscles of the Soft Palate.—The soft palate is the velvet-like curtain which hangs at the back of the mouth, and separates it from the back of the nasal cavities. The muscles it contains are the **tensor palati, levator palati, palato-glossus, palato-pharyngeus,** and a band forming the greater part of the little tongue dependent from the middle of the soft palate (the uvula), called **azygos uvulæ.**

Muscles of the Pharynx.—The pharynx or food-bag is the muscular cavity placed between the back of the mouth and the gullet. Its muscular structure is composed of three festooned layers, which are in part superimposed, and are known as the **superior, middle,** and **inferior constrictor** muscles of the pharynx. They grasp the food-bolus after it has left the mouth and by their compression force it into the upper part of the gullet.

Muscles of the Chest Wall.—The spaces between the ribs are filled by a double layer of muscular fibres, forming the **external** and **internal intercostal** muscles. In the **external** the fibres run downwards and forwards from the rib above to the rib below the space; when in action they raise the ribs, and, by enlarging the cavity of the chest, cause an influx of air, or, in other words, an **inspiration.** The fibres of the **internal intercostal,** on the contrary, run downwards and backwards, and act by depressing the ribs, so as to diminish the cavity of the chest, and cause an expulsion of air, or **expiration.**

Other muscles found on the chest wall are the **triangularis sterni,** clothing the back of the sternum, and the elevators of the ribs (**levatores costarum**), passing from the transverse processes of the vertebræ to the angles of the ribs.

Muscles of the Abdomen.—The abdominal wall is entirely muscular and tendinous, but the muscles and tendons are so arranged as to make a very strong and complex combination. Thus while providing for alterations in the capacity of the abdomen, the rise and fall of the wall in respiration, and for changes in the position and relations of the movable viscera,

the wall is so arranged as to ensure that the pressure shall be evenly distributed, and its elasticity is sufficient to allow of its sustaining strains and even blows without being ruptured.

The muscles which form the abdominal wall in front and at the sides are as follows:—

External Oblique.
Internal Oblique.
Transversalis.
Rectus.

The **External Oblique** muscle of the abdomen arises by fleshy slips from the outer surface of the eight lower ribs. Its fibres pass obliquely downwards and forwards, to end in a spread-out sheet of tendon, which covers the anterior half of the abdomen and extends downwards to the groin and pubes. In front it covers the rectus muscle, and in the middle line joins with the internal oblique and transversalis to form a common line of intersection, the **linea alba**, extending from the xiphoid cartilage to the symphysis pubis. The muscular fibres of the external oblique are attached below to the anterior two-thirds of the crest of the ilium. The lower border of its tendon, very strong and thick, stretches across at the groin, from the anterior superior spine of the ilium to the spine of the pubes, and is called **Poupart's ligament**. The arch thus formed allows of the passage of the vessels, nerves, and certain muscles from the abdomen to the thigh. Just above the spine of the pubes there is a weak spot in the external oblique, called the **external abdominal ring**; this gives passage in the male to the vas deferens (the duct of the testicle) and to the vessels and nerves in connection with it, which together form what is known as the **spermatic cord**; in the female it has passing through it the **round ligament** of the womb (uterus). This opening is so completely filled by the structures named, and covered in by fibrous and muscular bands, that there is no real aperture left, but, when extra strain is put upon the wall, portions of bowel or omentum are liable to be protruded, forming what is commonly called a "rupture" and technically "hernia".

The **Internal Oblique** is less tendinous than the external.

It springs below, and passes obliquely upwards and forwards. Arising from the crest of the ilium, outer half of Poupart's ligament, and a strong fascia behind (**lumbar fascia**), it is attached above to the edge of the cartilages of the four lower ribs; in the middle line it assists in the formation of the linea alba, and below it is attached (along with a part of the tendon of the next muscle) to the crest of the pubes and pectineal line. The back part of this muscle is tendinous, the middle fleshy, and the front part tendinous; the latter divides into two layers, one passing in front and the other behind the rectus, to reach the linea alba. The lower part of the muscle is defective just above the inner end of Poupart's ligament, a space being thus left which, from its being situated in the groin, is called the **inguinal canal**; it lodges the spermatic cord in the male and round ligament in the female.

From the lower border of the internal oblique, fibres pass down to the spermatic cord and testicle; these form the **Cremaster** muscle, so called because it suspends the testicle (*cremao*, I suspend).

The **Transversalis** muscle forms the third layer of the abdominal wall. As its name implies its fibres pass transversely across the abdominal wall, being connected behind with the fascia already mentioned (lumbar fascia), and through it with the lumbar vertebræ, also with the inner surface of the six lower ribs, the anterior part of the crest of the ilium, and the outer third of Poupart's ligament. In front it becomes tendinous and passes behind the rectus to the linea alba, while its lower edge ends by uniting with a part of the internal oblique to form a common tendon (the **conjoined tendon**), which is connected with the crest of the pubes and ilio-pectineal line. The **conjoined tendon** lies immediately behind the external abdominal ring, and thus compensates by its presence and strength for the deficiency in the external oblique at that point. As in the internal oblique, so in the transversalis, the lower border of the muscle is defective, leaving space for the spermatic cord, the **inguinal canal**.

The **Rectus** is a broad band of muscle passing up on one

side of the middle line of the abdominal wall. A remarkable feature in its structure is that the muscular fibres are interrupted by tendinous intersections forming **transverse lines**; there are three of these, none of them being as a rule below

Fig. 71.—Muscles of Abdominal Wall.

a, External oblique (turned down); *b b*, internal oblique; *c*, transversalis; *d*, conjoined tendon of external oblique and transversalis; *e*, rectus, with sheath opened; *f*, transversalis fascia; *g*, triangular fascia; *h*, cremaster; *i*, infundibular fascia. [Wood.]

the navel. The rectus is inclosed in a strong sheath formed by the tendons of the oblique and transverse muscles; in front there is in the upper two-thirds the tendon of external oblique and half that of the internal, and behind, the transversalis and the other half of the tendon of the internal oblique. In the lower third, the whole of the tendons pass in front, leaving the sheath entirely wanting behind; this arrangement allowing of

the direct action of the rectus on the urinary bladder when distended, and on the womb at the birth of the child.

The **Inguinal Canal** has been already spoken of. It is an oblique canal in the abdominal wall just above the groin, terminating below in the opening in the external oblique, the **external abdominal ring**, and communicating above with the abdominal cavity by an opening in the abdominal fascia, the **internal abdominal ring**. In the male it contains the spermatic cord, and in the female the round ligament of the uterus. Down this canal the testicle travels in its descent from the abdomen to the scrotum before the birth of the child, and as a consequence the wall here is weakened, and not unfrequently bowel is forced down the canal, forming an **oblique inguinal hernia**.

The abdominal muscles by their general and even compression keep the abdominal organs in their proper relation to each other, and by supporting them ensure the maintainence of proper conditions for their healthy action. These muscles are also brought into play in breathing, as they assist in the act of expiration, or the expulsion of air from the chest; they also play a prominent part in the expulsion of urine from the urinary bladder, the contents from the bowel in defæcation, and the child from the womb at the birth. They are also of use in bending the body forward.

At the back of the abdomen two muscles of considerable importance are found. One of these, the **quadratus lumborum** passes from the pelvis to the last rib, being also connected with the tranverse processes of the lumbar vertebræ; its chief uses are to bend the spine to the side, and to fix the last rib. The other muscle, called **psoas**, runs down from the lumbar vertebræ, beneath Poupart's ligament to the thigh, where it is attached to the lesser trochanter of the femur. It serves to bend the thigh on the abdomen.

Between the chest and abdomen is the most remarkable and important muscle of the body, the **diaphragm**. It forms a complete division between the two cavities, and is also the chief muscle for carrying on the work of respiration.

The **Diaphragm** forms a dome, with the convexity directed upwards and the concavity downwards. It is attached behind to the front of the bodies of the lumbar vertebræ, and at its circumference is fixed to the inner surface of the lower six ribs. The central part of the muscle is tendinous, the outer part is fleshy; the pillars which connect it with the vertebral bodies are partly fleshy and partly tendinous. On its upper surface it is connected with the sac which encloses the heart, the pericardium; its upper surface also is in part covered by the pleura, and its lower by the peritoneum. There are several openings in the diaphragm, one of them giving passage to the abdominal aorta (the great vessel carrying blood to the abdomen and the limbs), another to the gullet and vagus nerves, and a third to the inferior vena cava.

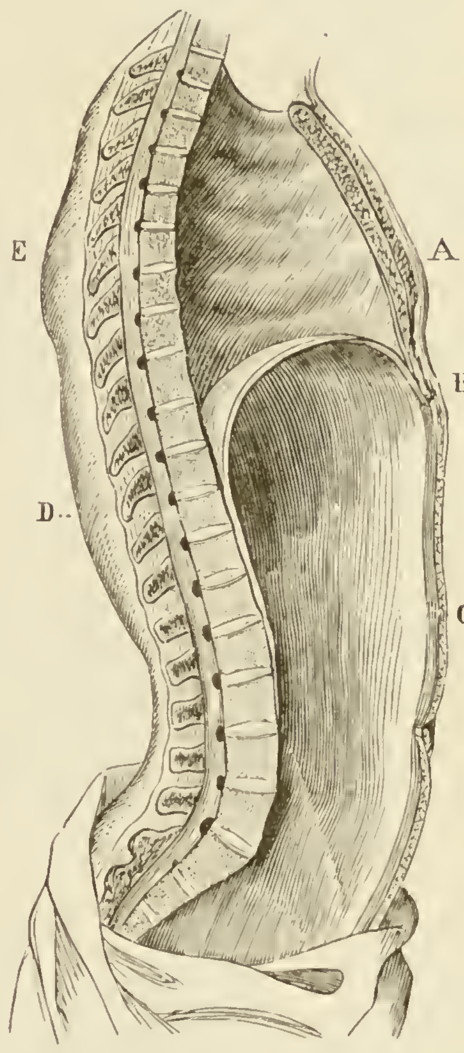


Fig. 72.—A, Chest wall; B, diaphragm; C, abdominal wall; D, dorsal vertebræ; E, shoulder.

The diaphragm forms the floor of the chest, and by its descent causes an increase in the depth of that cavity; this enlargement in the capacity results in an ingress of air, or the act of *inspiration*; when it is relaxed it rises by its own elasticity, the cavity of the chest is diminished in depth, and air is consequently forced out to make room for its rise (*expiration*). In forced expiration the abdominal muscles also assist, for by pressing up the abdominal organs against the diaphragm, they cause it to rise.

The diaphragm receives its motor supply from the two phrenic nerves, which are consequently regarded as the great nerves of respiration. They pass through the muscle and are distributed on its under surface.

Muscles of the Upper Limb.*—A large triangular sheet of muscle passes from the front of the chest to the arm, and forms one of the anterior boundaries to the arm-pit or axilla; this is called the **pectoralis major**. It is attached at its origin to the collar-bone, breast-bone, and costal cartilages; at its insertion it is fixed to the outer edge of the bicipital groove on the humerus. When the shoulders are fixed, the pectoralis major draws the ribs upwards, enlarges the cavity of the chest, and so acts as a powerful accessory to inspiration. When the arms are free, the two muscles draw them across the chest, as in the action of flogging the chest performed by cabmen and others in cold weather. This muscle also draws the body towards the arms in climbing.

Beneath this muscle is a smaller one, the **pectoralis minor**, also triangular in shape, and passing from the second, third, and fourth ribs, to the coracoid process of the scapula. Like the pectoralis major it assists forcible inspiration; it also aids in drawing the blade-bone forward upon the chest wall.

Forming a triangular covering to the shoulder-joint is a muscle of much importance, the **deltoid**, so called because of its resemblance in shape to an inverted Greek letter delta (Δ). The deltoid is connected above with the clavicle and spine of the scapula, and below is inserted into a large triangular impression on the outer side of the middle of the shaft of the humerus. It is the chief means by which the arm is carried outwards and upwards from the body.

At the back of the shoulder, a large spread-out muscle passes upwards to the humerus from the back and loin. From its wide expanse at the back it is named **latissimus dorsi** (broadest muscle of the back). It is inserted into the bicipital groove, and when in action draws the arm downwards and backwards.

Between the scapula and chest wall another large sheet of muscle is placed, called the **serratus magnus**. It is attached to the outer surface of the eight upper ribs by muscular slips which look like saw-teeth (hence the name, from L. *serra*, a

* The reader is referred to the plate at the end of the book, where illustrations of these muscles are given.

saw), and passes from thence to the posterior border of the scapula. When the arm is fixed this muscle assists in raising the ribs and increasing the capacity of the chest; it is, therefore, a muscle of forced inspiration. Its nerve supply is the

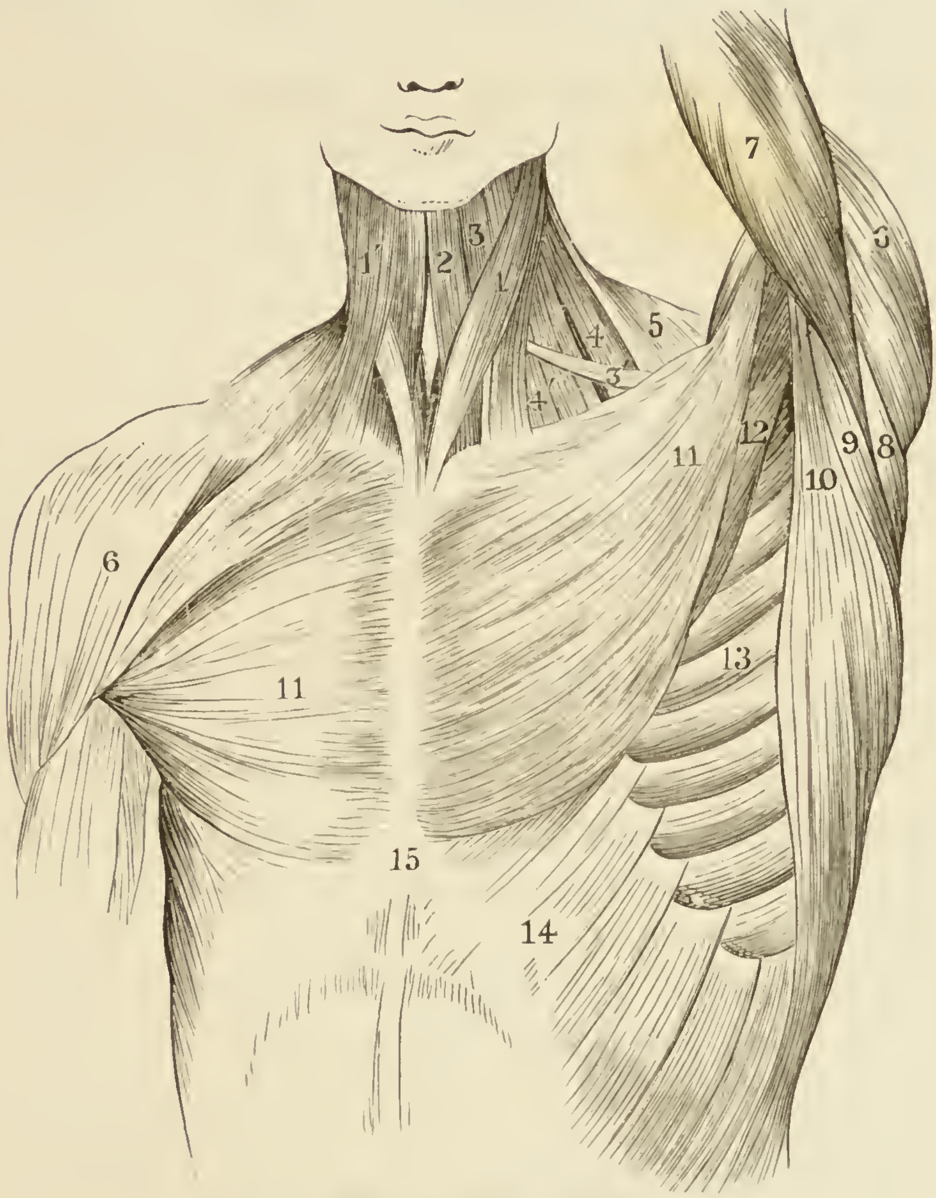


Fig. 73.—Muscles of Chest Wall and Shoulder.

1, Sterno-mastoid; 1', platysma myoides; 2, sterno-hyoid; 3, omo-hyoid; 3', posterior belly of omo-hyoid; 4, elevator of the angle of the scapula; 4', anterior scalene muscle; 5, trapezius; 6, deltoid; 7, triceps; 8, teres minor; 9, teres major; 10, latissimus dorsi; 11, pectoralis major; 12, pectoralis minor; 13, serratus magnus; 14, external oblique of abdomen; 15, position of ensiform cartilage. [Quain.]

posterior thoracic, the nerve named *external respiratory* by Sir Charles Bell, because of its distribution to this muscle.

Covering the shoulder-joint and in direct connection with the capsule are several short muscles, which serve to support the joint, and act also as rotators of the humerus. Thus in

front there is the **subscapularis**, springing from the front of the scapula and terminating by being attached to the lesser tuberosity of the humerus; it acts by rotating the humerus inwards. At the back of the joint we find four muscles, the **supra-spinatus, infra-spinatus, teres minor**, and **teres major**; the two former come from the scapula, one above and the other below the spinous process, the other two spring from the outer border of the same bone. The supra-spinatus, infra-spinatus, and teres minor are inserted into the greater tuberosity of the humerus, and act as external rotators of the humerus; the teres major is attached to the inner side of the bicipital groove, and acts by rotating the humerus inwards and carrying the arm inwards and a little backwards.

Three large muscles and one small one form the muscular mass in front and at the back of the arm; in front are the biceps, coraco-brachialis and brachialis anticus, and behind, the triceps.

The **Biceps** (so called from its having two heads) is a beautiful muscle, forming a thickly rounded mass in front of the upper arm. Above, it consists of two portions, or heads, one of them (partly muscular and partly tendinous) being attached with the coraco-brachialis to the coracoid process of the scapula, the other (tendinous) springs from the upper part of the glenoid cavity of the scapula, and, after traversing the shoulder-joint, runs down a narrow groove between the inner and outer tuberosities of the humerus. Below, the biceps terminates in a round tendon, but from this there is given off a thin membranous slip, the **bicipital fascia**; the former is inserted into the back part of the tubercle of the radius, the latter passes to the front of the muscles of the forearm and gets connected with them. The biceps is not, as a rule, attached to the humerus, but sometimes there is a third head connected with that bone.

The main action of the biceps is to flex the elbow, and in so doing it acts as a lever of the third order; it also raises and carries forward the arm by acting over the shoulder-joint. It is a powerful supinator, this action depending on its being

attached to the back and not to the front of the tubercle of the radius; by means of the bicipital fascia it assists the muscles of the forearm in their action of flexing the hand. It is supplied with nerve power by the external cutaneous nerve.

The Orders of Lever as exemplified in the Action of the Muscles.—Three orders of lever are described in mechanics according to the position of the fulcrum, weight, and power. In the **first order**, fig, 74, the fulcrum is placed between the weight and power; it is exemplified in the movements of the head on the atlas, where the fulcrum is at the occipital condyles.

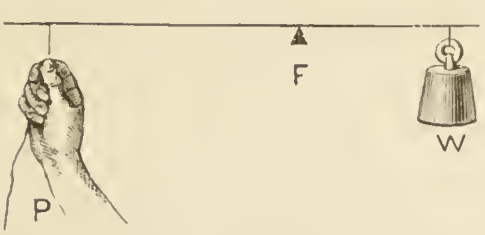


Fig. 74.—Lever of the First Order.

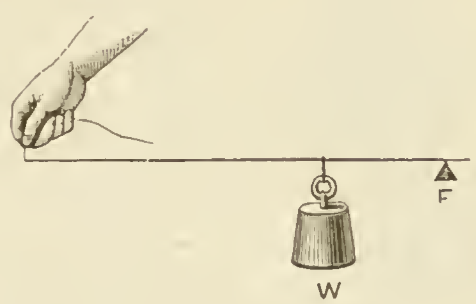


Fig. 75.—Lever of the Second Order.

the power at the back of the neck, and the weight is formed by the face and front part of the skull. This form of lever is employed in balancing, and it is therefore called the **lever of stability**. Other examples in the human body are the balancing of the vertebral column and pelvis on the head of the femur, and of the foot on the lower end of the tibia; this lever is also used when the arm is straightened by the action of the triceps muscle.

In the **second order**, fig. 75, the weight is between the power and the fulcrum. In all levers the force exerted is proportional to the distance between the fulcrum and the point of application of the force; but it has been already said that in this form the force is always placed further away from the fulcrum than is the weight, so that there is always a mechanical gain, or, to put it another way, the power required to move the weight is always less than the weight itself. This lever is therefore called the **lever of power**. It has this disadvantage that the power must always move through a greater distance than the weight, and for this reason it is very little employed

in the human economy. It is, however, exemplified when a person stands upon his toes (fig. 76), for in this case the fulcrum is at the ball of the toes, the weight is transmitted down the bones of the leg to the foot, and the power is in the muscles of the calf.

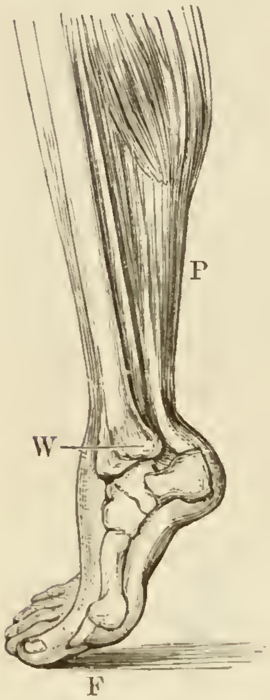


Fig. 76.—Lever of Second Order, illustrated by standing on tiptoe. P, power; W, weight; F, fulcrum.

The **third order** of lever (fig. 77) has the power between the weight and the fulcrum. It is the form in which there is actual loss of mechanical power instead of gain, for the power arm is very much shorter than the weight arm, and consequently the power needed to move the weight is greater than the weight itself. This fault is more than compensated for by more rapid action, for it will be observed that the power only requires to move through a small space to cause an extensive displacement of the weight. Hence it is called the **lever of rapidity**. It is very much the most frequently employed of the three levers in the human body. We have mentioned that the biceps in action is an example of this form; the fulcrum is at the elbow, the power applied at the tubercle of the radius and the weight is the hand and forearm. The action of the deltoid is another example, and there are many more.

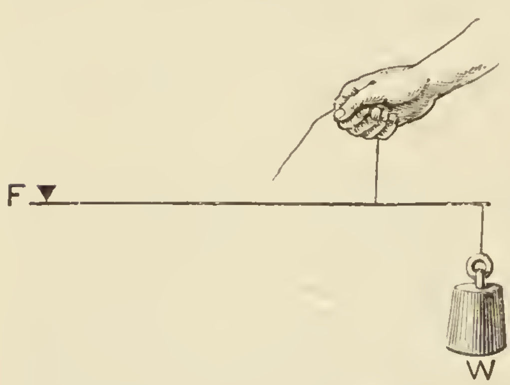


Fig. 77.—Lever of the Third Order.

The **Coraco-brachialis** is a slip of muscle united with one head of the biceps; it passes from the coracoid process of the scapula to the inner side of the shaft of the humerus.

The **Brachialis anticus** muscle clothes the front of the lower end of the humerus, and its tendon passes across the front of the elbow-joint to be attached to the coronoid process of the ulna. It is a powerful flexor of the elbow-joint, and also serves to protect and support that joint.

At the back of the arm the whole of the humerus is covered by a mass which, from its being split up above into three portions has been named the **triceps**. Of the three heads thus formed the *middle* one is attached just below the glenoid cavity of the scapula; the *outer* one to the outer and back part of the humerus, high up; and the *inner* to the inner and back part of that bone, low down. The muscle terminates in a flattened tendon which is attached to the back part of the olecranon process of the ulna. Its action is to extend the forearm, and its nerve supply is the musculo-spiral nerve.

Muscles of the Forearm.—Two groups of muscles can be readily distinguished in the forearm, namely, those springing from the internal condyle of the humerus, the group of *flexors and pronators*; and those arising from the external condyle and the ridge above it, the group of *extensors and supinators*. The muscles of both groups are constructed on the same plan, being massed together at their origin, and so intimately united by fibrous intersections as to be difficult to separate. They all terminate, also, in long tendons contained in synovial sheaths, and pass across the front or back of the wrist to reach the hand.

Muscles of the front of the Forearm.—Most of the muscles of the front of the forearm belong to the inner group mentioned above, but some of them do not extend above the elbow, but spring from the bones of the forearm. The following are the chief:—

The **Round Pronator (pronator radii teres)** passes obliquely across the upper part of the forearm, immediately below the elbow, to be attached to the middle of the outer side of the radius. The two flexors of the wrist, the **flexor carpi radialis** and **flexor carpi ulnaris**, are placed the former on the outer and the latter on the inner border of the front of the forearm. A very small muscle with a long tendon, the **palmaris longus**, usually lies in the middle of the forearm, and passes to the deep fascia of the palm of the hand (**palmar fascia**), which it makes tense when the hand is flexed.

The most important muscles of this group are the superficial and deep flexors of the fingers. The **Superficial Flexor (flexor**

sublimis digitorum) arises from the inner condyle of the humerus, coronoid process of the ulna, and shaft of the radius, as a fleshy mass which divides about the middle of the forearm into four tendons arranged in two pairs. The tendons pass beneath a fibrous arch, stretched across from the scaphoid and trapezium to the unciform bone, and called the **anterior annular ligament**; on reaching the palm they separate to pass to the four fingers, and terminate by being attached to the middle phalanges of those fingers. Just before each tendon ends it splits and allows the tendon of the deep flexor to pass through

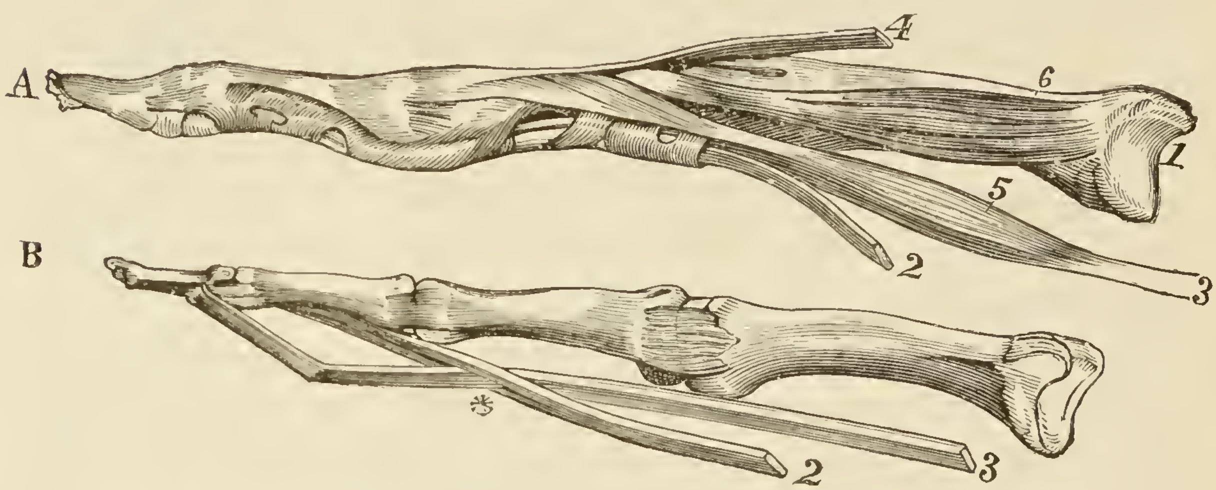


Fig. 78.—Bones of the Fingers, shewing the Attachment of the Tendons. In A the tendons are enclosed in the fibrous sheath, in B the sheath has been removed.

1, Metacarpal bone; 2, tendon of the superficial flexor; 3, tendon of the deep flexor; 4, tendon of the extensor muscle of the fingers; 5, lumbricalis muscle; 6, interosseous muscle; *, tendon of deep flexor passing through a slit in that of the superficial. [Wilson.]

it (fig. 78 *). On the front of the first and second phalanges the tendons of the deep and superficial flexors are contained in small canals formed in part by the groove in the front of the bone and partly by fibrous bands thrown across. It is the existence of these canals and their great strength that makes inflammation along the tendons of the fingers so very painful, especially in that form of the disease known as *whitlow*.

The **Deep Flexor** (**flexor profundus digitorum**) lies beneath the superficial; it springs from the front and inner side of the ulna, and divides into four tendons which pass beneath the annular ligament into the palm; at the middle of the second phalanx of the finger each tendon passes through the slit in that of the superficial muscle, and goes on to be inserted into

the base of the last phalanx. In connection with the tendons of the deep flexor are four little worm-like muscles, the **lumbricales** (*lumbricus*, an earth-worm); they pass from these tendons to join those of the extensor muscle of the fingers (fig. 78, 5). They are sometimes named **fidicini** or "fiddlers' muscles", from the supposition that they are of especial service in playing the violin.

Besides the deep flexor, one other muscle of the front of the forearm does not extend up as far as the elbow, this is the **special flexor of the thumb (flexor longus pollicis)**. It springs from the front of the radius, and terminates in a round tendon which runs beneath the annular ligament and ends by becoming attached to the last phalanx of the thumb. It is this muscle which gives to the thumb the power of individual flexion of the terminal phalanx.

Muscles and Fascia of the Palm of the Hand.—The palm has a very strong layer of fascia, the **palmar fascia**, situated just beneath the skin and intimately connected with it. It is connected above with the palmaris longus muscle, and is also attached to the anterior annular ligament; below it spreads out in a fan-like manner, and divides into strands which pass to the ligaments and sheaths of the tendons of the fingers. It has beneath it the nerves, tendons, and arteries of the palm. By its presence it keeps the tendons in place when the muscles are in action, and causes the formation of the hollow of the palm.

The muscles of the palm consist of (1) a group belonging to the thumb; (2) a group belonging to the little finger; and (3) muscles placed between or upon the metacarpal bones.

1. The **muscles of the Thumb** consist of an **opponent** muscle, which is used in bringing the tip of the thumb against that of each of the other fingers, an **abductor**, a **short flexor**, and an **adductor**.

2. The **muscles of the Little Finger** consist of an **abductor**, which is a continuation of the ulnar carpal flexor from the pisiform bone to the first phalanx, a **short flexor**, and an **opponent** muscle.

3. The **muscles in connection with the Metacarpal bones** are called **interosseous**; they are seven in number. Three, named **palmar interosseous,** lie on the palmar face of the bones; when in action they draw the first, third, and fourth fingers towards the middle one, or are *adductors*. The remaining four

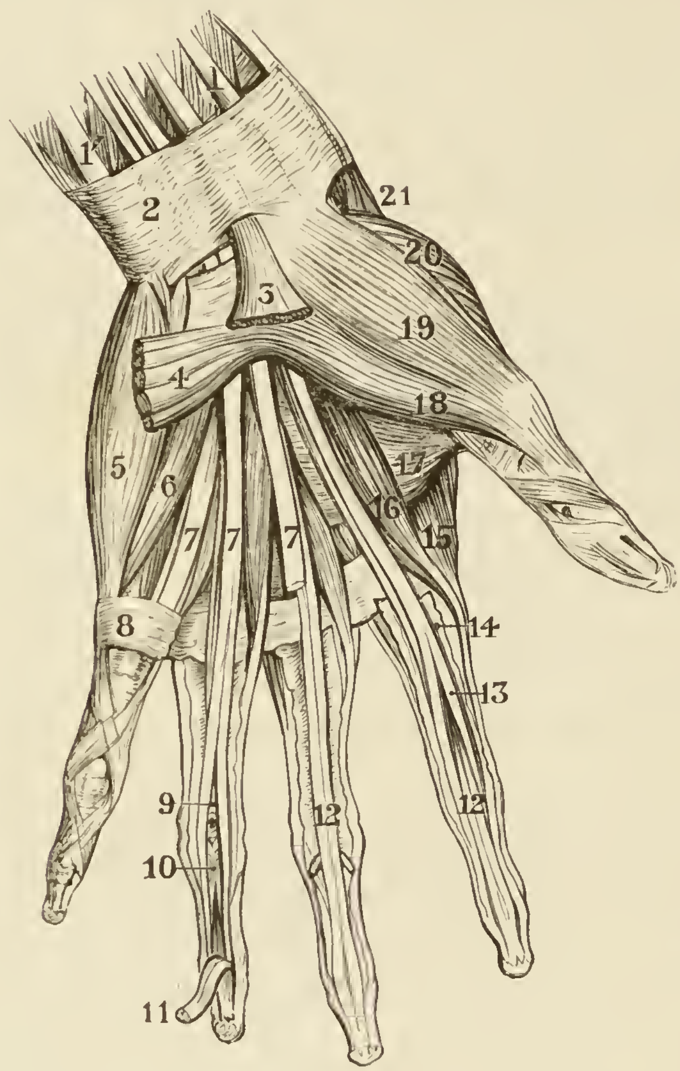


Fig. 79.—Muscles of Palm of Hand.

1, Flexor carpi radialis; 1', flexor carpi ulnaris; 2, anterior annular ligament; 3, palmaris longus; 4, palmaris brevis; 5, abductor of little finger; 6, opponens of little finger; 7, 7, 7, tendons of superficial flexor of fingers; 8, fibrous case for tendons; 9, tendon of superficial flexor splitting to let deep flexor tendon through; 10, anterior ligament of joint of finger; 11, deep flexor tendon (cut); 12, 12, deep flexor tendons (uncut); 13, superficial flexor; 14, ligament fixing tendon in its sheath; 15, first dorsal interosseous muscle; 16, lumbricalis muscle; 17, adductor of thumb; 18, short flexor of thumb; 19, abductor of thumb; 20, opponens of thumb; 21, extensor of thumb. [Morris.]

are called **dorsal interosseous**; they fill the interspaces between the metacarpals, and when in action draw the first, second, and third fingers away from the middle line of the hand, or are *abductors*.

The muscles of the front of the forearm and palm of the hand get their nerve supply from the median and ulnar nerves.

Muscles of the Back of the Forearm and Hand.—Some of the muscles of the back of the forearm arise from the external condyle and the ridge above it, others are connected only with the back of the bones of the radius and ulna and the

interosseous membrane; they are thus divisible into a superficial set of long muscles and a deep set of short muscles.

The long muscles consist of the following:—

The **Long Supinator** arises from the upper part of the ridge above the external condyle of the humerus, and passes down the outer border of the forearm a little towards the front; it ends in a flat tendon which is inserted into the styloid process of the radius. Although named supinator, its chief action is to flex the forearm. When the hand is pronated it takes part in the early stage of the act of supination. Its nerve supply is the musculo-spiral nerve.

Beneath the supinator longus are the two radial extensors of the carpus, **extensor carpi radialis longior** and **extensor carpi radialis brevior**; the former is attached above to the ridge above the external condyle, and below its tendon is inserted into the base of the metacarpal bone of the index finger; the latter passes from the external condyle to the base of the metacarpal bone of the middle finger. Their actions are indicated by their names and attachments.

The **Common Extensor (extensor communis digitorum)** arises from the external condyle of the humerus, becomes tendinous about the upper third of the forearm, and divides into four tendons for the four fingers. The tendons pass beneath a fascial band, the **posterior annular ligament**, at the back of the wrist, then diverge from each other, and run over the posterior aspect of the metacarpal bones to reach the fingers. Each tendon spreads out over the back of the phalanges, and supplies the place of a posterior ligament in the metacarpo-phalangeal and inter-phalangeal joints. A little beyond the base of each first phalanx the extensor tendon receives the attachment of the lumbricalis and interosseous muscles. A special slip of this muscle forms the **extensor of the little finger**, and in consequence that finger has two tendons.

The **Ulnar Carpal Extensor (extensor carpi ulnaris)** arises from the external condyle of the humerus and back of the ulna, and is inserted into the base of the metacarpal bone of the little finger.

The short muscles of the back of the forearm are as follows:—The special extensors of the thumb are three in number, **extensor ossis metacarpi pollicis**, extending the metacarpal bone; **extensor primi internodii pollicis**, for the first phalanx; and the **extensor secundi internodii pollicis**, for the terminal phalanx. There is also a special extensor of the index finger (**extensor indicis**).

The tendons of all these muscles, excepting the supinator longus, pass through tunnels beneath the posterior annular ligament, and lie in grooves on the back of the radius and ulna.

Muscles of the Lower Limb.*—The muscles of the thigh are very large and powerful. They are incased in what is probably the strongest fascia in the body, the **fascia lata**. This fascia is especially strong on the outer side of the thigh, where it gives attachment to two muscles, and is continued below the knee to the tibia, as a ribbon-like band, the **ilio-tibial band**. A little below the groin is an opening in the fascia called the **saphenous opening**, for the passage of internal saphena vein; through this weak spot one form of protrusion of the bowel, called *femoral hernia*, takes place.

Muscles of the Front of Thigh.—Passing oblique across the front of thigh is a very long and comparatively narrow muscle, the **sartorius**; it arises from the anterior superior spine of the ilium, and runs downwards and inwards (passing a little behind the knee) to end in a flattened tendon which is inserted into the tibia a little internal to the tubercle. It is the muscle used in crossing the legs, hence it is called the *tailor's muscle* (Lat. *sartor*, a tailor).

The great mass of muscle covering the front of the femur forms a complicated arrangement very difficult to divide into separate muscles. It is consequently described under one title as the **quadriceps** (four-headed) **extensor** muscle of the thigh. The most distinct portion of it is called **rectus**; it springs from the anterior inferior spine of the ilium and from a rough impression above the acetabulum, and passes down the front of

* The reader is referred to the plate at the end of the book for illustrations of these muscles.

the thigh to be attached to the upper border of the patella. Other parts of the muscle, arising from the shaft of the femur, are named, **vastus externus, vastus internus,** and **crureus**; they also are inserted into the patella. From the patella a thick and strong ligament passes to the tubercle of the tibia. This process of bone may, therefore, be properly regarded as the real insertion of the quadriceps, and the knee-pan as a sesamoid bone formed in its tendon.

These muscles are the extensors of the leg upon the thigh, and are used in kicking; the rectus also flexes the thigh on the abdomen. Their nerve supply is the anterior crural nerve.

On the inner side of the thigh is a definite group of muscles, called the **adductors** because their chief action is to draw the leg inwards towards the middle line of the body. They are **adductor longus, adductor brevis, adductor magnus,** and **gracilis**; they are connected above with the ramus of the ischium and pubes, and terminate below in the linea aspera of the femur, excepting the gracilis, which runs below the knee to reach the tibia. They are all supplied with motor power by the obturator nerve.

Muscles of the Buttock and Back of Thigh.—The buttock is formed by several large muscles covered by a very thick layer of fat. The chief muscles are the **gluteal**, three in number, of which the first one is so large as to well deserve the distinctive title of **gluteus maximus**; the others being named **gluteus medius** and **gluteus minimus**. They are all three fan-shaped, all arise from the outer surface of the ilium, and are all inserted into the femur. They are the chief means by which the erect posture is maintained, and this explains why they are so much more developed in man than in other animals. They also abduct the thigh.

Beneath them are a number of small muscles used for rotating the thigh outwards, whose names it is not necessary here to specify.

The muscles of the back of the thigh form a group known as the **ham-strings**, because their tendons form the lateral boundaries of the *popliteal space* or *ham*. They are the

semi-membranosus, semi-tendinosus, and **biceps.** They all spring from the tuberosity of the ischium, the first-named by itself, and the last two by a common origin. The semi-membranosus and semi-tendinosus form the inner ham-strings, and are inserted into the tibia. The biceps forms the outer ham-string; as its name indicates, it has two heads, one arising with the semi-tendinosus from the tuberosity of ischium, the other from the back part of the femur; it is inserted into the head of the fibula. These muscles flex the knee and extend the hip; in the latter action the mechanism is that of a lever of the first order. They are supplied by the great sciatic nerve.

Muscles of the Leg.—On the front of the leg, between the knee and ankle, there are only three muscles of any importance—the anterior tibial, long extensor of the toes (extensor longus digitorum) and special extensor of the big toe.

The **Anterior Tibial (tibialis anticus)** has a long tendon which passes in front of the internal malleolus of the tibia to the foot, where it is inserted into the internal cuneiform bone and base of the metatarsal of the big toe. It draws up the inner border of the foot, and is one of the means by which the arch is supported.

The **Long Extensor** also ends in a long tendon; this passes beneath a band of fascia in front of the ankle, called the **anterior annular ligament,** and on the back of the foot divides into four tendons for the four outer toes. Its name indicates its use.

The **Special Extensor of the Big Toe** also passes beneath the anterior annular ligament, and terminates by being attached to the phalanges of the big toe.

On the back of the foot there is a **short extensor of the toes.** This arises as a small fleshy mass from the os calcis, and the four little tendons derived from it go to the four greater toes.

On the back of the leg the most important muscles are those of the calf; they are the gastrocnemius and soleus.

The **Gastrocnemius** forms the great part of the calf. It is attached above by two heads to the back of the lower end of the femur, immediately above the condyles, and ends by form-

ing with the soleus the remarkable tendon at the back of the ankle, the **tendo Achillis**.

The **Soleus** does not extend above the knee-joint; it arises from the back of the tibia and head of the fibula, and terminates in the tendo Achillis. That tendon is the thickest and strongest in the body, being capable of supporting considerably more than the total weight of the person. It is inserted into the prominent projecting tuberosity of the heel-bone (os calcis).

A very small muscle, called the **plantaris**, is associated with the gastrocnemius and soleus; it arises as a small fleshy mass from above the external condyle of the femur, and forms a long and very thin tendon which passes between the muscles of the calf to become attached to the heel-bone.

The muscles of the calf are so strongly developed because they are the means by which the body is raised and projected forwards in walking or running.

Beneath the calf lie the flexor muscles of the ankle and foot, attached to the back of the tibia and fibula. They correspond with the extensors on the front of the leg, and are the posterior tibial, long flexor of the toes, and special flexor of the big toe.

The **Posterior Tibial** muscle (**tibialis posticus**) ends in a long tendon, which passes behind the internal malleolus of the tibia to the foot, where it is inserted into the scaphoid and internal cuneiform bones. It draws up the inner border of the foot, and is the chief means by which the arch is supported.

The **Long Flexor** also ends in a long tendon, which passes round the inner ankle to reach the sole of the foot. Here it forms a connection with the special flexor of the big toe and with a muscle of the foot called the *accessory muscle*, and ends in four tendons for the four lesser toes.

The tendon of the **special flexor of the big toe** runs behind the inner ankle, and, passing into the sole of the foot, terminates by being attached to the base of the last phalanx of the big toe. The action of these two muscles is indicated by their names.

On the outer side of the leg are two long muscles covering

the fibula, and named from this attachment (Gk. *perone*, the fibula) the **peroneus longus and brevis.** They have long tendons, which run round the outer ankle to the foot, the shorter muscle being inserted into the base of the metatarsal bone of the little toe, and the longer into that of the big toe; the latter crosses the under surface of the foot in a groove formed chiefly in the cuboid bone. These muscles raise the outer edge of the foot, and are instrumental in maintaining the outer arch.

Muscles of the Foot.—These bear a general resemblance to those of the hand. Thus, there is an **abductor,** a **short flexor,** and an **adductor of the big toe,** and an **abductor** and a **short flexor of the little toe;** there is no opponent muscle, and the power the thumb possesses of opposing to each of the fingers is altogether wanting in the big toe. Again, there are three **plantar** and four **dorsal interosseous** muscles, and their connections and actions correspond with those of the interosseous of the hand, with this exception, that the middle line of the foot runs through the second toe, that of the hand through the third finger. The muscles of the foot unrepresented in the hand are the **flexor brevis digitorum,** which, however, takes the place of the superficial flexor of the forearm and hand, the **accessory muscle** already mentioned, and a small transverse muscle (**transversus pedis**), crossing the heads of the metatarsal bones.

ANGIOLOGY.

THE HEART, BLOOD-VESSELS, AND LYMPHATIC VESSELS.

The heart, the organ by means of which the blood is propelled to every part of the body, is composed of striped muscle, differing, however, in many important respects from the muscle which forms the organs of locomotion (see p. 22).

It is situated in the chest between the lungs, and is partly overlapped by them. It is somewhat cone-shaped, with the base directed upwards and a little backwards, and the apex downwards and forwards. The heart is placed more to the left than to the right, extending for about an inch to the right of the breast-bone and two and a half inches to the left. To map out on the chest-wall the position of the heart in a healthy person, draw first a line across the chest on a level with the upper border of the third costal cartilage, and another at the union of the sternum and xiphoid cartilage; these will mark out the upper and lower limits of the heart. Next draw a vertical line an inch outside the right border of the sternum, and another $2\frac{1}{2}$ inches outside the left border:

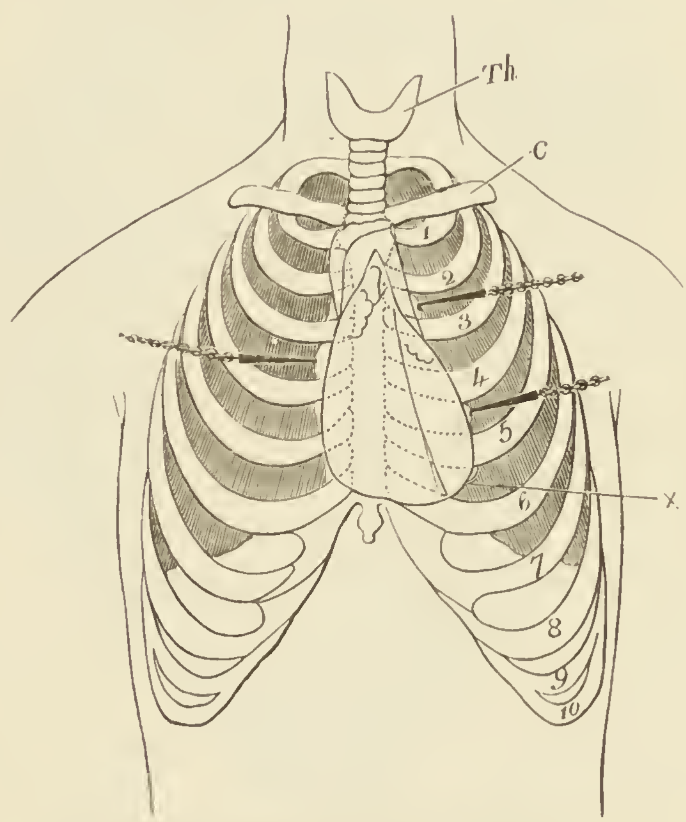


Fig. 80.—The Position of the Heart and Lungs.

The lungs are represented shaded and drawn aside by hooks to show the extent of the heart, which is mapped out by continuous lines. *c* shows the position of the collar-bone, and 1, 2, 3, &c., indicate the ribs. The outline of the breast-bone and ribs in dotted lines marks the parts that would require to be removed to expose the heart fully in the body. X points to the apex of the heart, occupying a position between the fifth and sixth ribs. *Th.* is the thyroid gland.

these will mark the extreme lateral limits. By rounding the angles of this square a fair representation of the area occupied by the heart will be obtained. The **apex** of the heart is felt beating in the space between the fifth and sixth ribs, on the left side, about an inch below the nipple, and nearer the middle line.

When the lungs are fully expanded the portion of the heart uncovered is not larger than a circle with a diameter of an inch and a half.

The heart varies in size in different persons, and is usually smaller in the female than in the male. On an average it is about 5 inches long, $3\frac{1}{2}$ inches broad, and $2\frac{1}{2}$ inches thick, and may be roughly stated to be the size of the closed fist of the individual. Its weight is about eleven ounces in the male and nine in the female.

It is kept in its place by the great vessels entering and leaving it; these are all situated at the base, the whole of the rest of the organ is consequently free. It is enclosed in a membranous bag, the **pericardium.** This is really a double layer of membrane, one portion forming the containing sac and the other covering the surface of the heart; between the two a small quantity of serous fluid is poured out, the **pericardial fluid,** which serves to lubricate the membrane and permit of the movements of the heart taking place without undue friction. The pericardium passes on to the roots of the great vessels at the base of the heart, and it is here that the two layers become continuous. The lower part of the pericardial sac is attached to the upper surface of the central tendon of the diaphragm, and rises and falls to a limited extent with the action of that muscle.

The heart is much thicker on the left side than on the right, because the former has to propel the blood throughout the body (**greater circulation**), while the latter only has to send it through the lungs (**lesser circulation**). The interior is hollowed out into chambers or cavities, lined with a delicate serous membrane, the **endocardium**; and the same structure forms the valves which determine the course the circulation shall take. In addition to the muscular tissue, and the serous mem-

branes on the outside and inside, the heart-wall contains fibrous tissue, fat, blood-vessels, lymphatics, and nerves. The muscular fibres are disposed in a very complex fashion, the several layers being more or less spiral in arrangement. On the surface (fig. 81, a little above C.*r.*), it will be noted that a groove runs transversely around the organ a little below its base, and another (C.*l.*) runs obliquely downwards from base to apex, both on the front and back of the heart. The organ is thus divided into four portions, which correspond to the four chambers in its interior, the right and left auricle and the right and left ventricle. The transverse groove is the **auriculo-ventricular groove.** It has lying in it the arteries, veins, and nerves for the supply of the heart-wall. The oblique groove is the **inter-ventricular groove,** and in like manner lodges arteries, veins, and nerves.

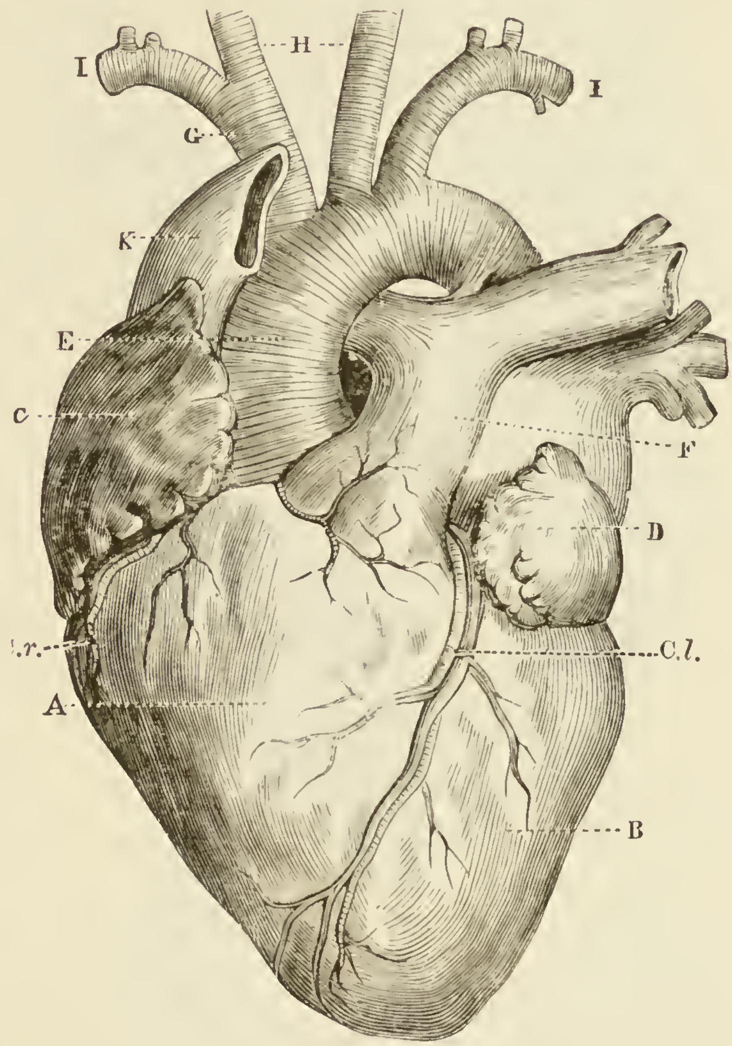


Fig. 81.—The Heart.

A and B, right and left ventricles; C and D, right and left auricles; E, aorta; F, pulmonary artery; G, innominate artery, branch of aorta; H, right and left carotid branches (to head and neck); I, I, subclavian branches (to upper limbs); K, superior vena cava; L, pulmonary veins; C.*r.*, right coronary vessels; C.*l.*, left coronary vessels.

The auricles are distinguished externally by possessing ear-like processes, the **auricular appendages** (Lat. *auricula*, a little ear), projecting from their upper part, and partly obscuring the base of the great vessels.

Passing into the right auricle two large veins are seen, one

above, the **superior vena cava** (fig. 81, K), and the other below, the **inferior vena cava**; they carry the venous blood into the heart. On the left side of the superior cava is the large artery of the body, the **aorta**; it springs from the left ventricle, and turns first to the right, then upwards and to the left, so as to form an arch. Lying across the root of the aorta is a large vessel proceeding from the right ventricle and passing upwards and to the left; it is the **pulmonary artery**, and conveys the blood to the lungs. Beneath the arch of the aorta it divides into two branches, one for each lung. At the back of the heart four vessels are found passing into the left auricle; they are the **pulmonary veins**, which carry the purified blood back to the heart from the lungs.

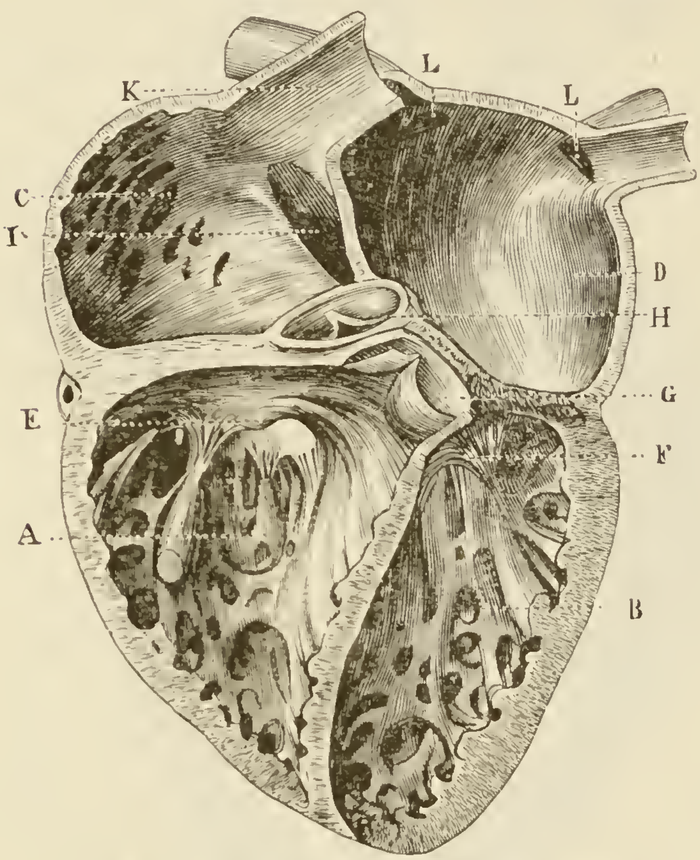


Fig. 82.—The Heart opened to show its Chambers.

A and B, Right and left ventricles; C and D, right and left auricles; E, tricuspid, and F, mitral valves; G, pulmonary artery; H, aorta; I, orifice of inferior vena cava; K, superior vena cava; L, L, orifices of pulmonary veins; M, termination of septum; P, papillary muscle.

The front of the heart is chiefly formed by the wall of the right ventricle, but the apex is formed by the left ventricle; the right border is formed by right auricle, the left by left ventricle, and the posterior surface mainly by left auricle and left ventricle.

Interior of the Heart.—The four cavities of the heart are probably all of equal capacity, but the auricles generally have the appearance of being smaller than the ventricles.

The **Right Auricle** receives the blood from the two venæ cavæ and from the substance of the heart itself. In the appendix the interior is marked by peculiar raised muscular bands arranged like the teeth of a comb (**musculi pectinati**). The

opening between the auricle and ventricle is of sufficient size to admit three fingers.

The **Right Ventricle** has on its wall a great number of irregular prominences, formed by the muscular wall, covered by endocardium (**columnæ carneæ**). Two of these, named **musculi papillares**, are only attached by one end to the wall and by the other are connected with the valve segments by fine **tendinous cords.** The **auriculo - ventricular valve,** which serves when brought into action to close the opening between the auricle and ventricle, is of three flaps or segments and hence is known as the **tricuspid valve.** At the upper part of the ventricle a funnel-shaped prolongation of the cavity is continued upwards to the pulmonary artery; it is called the **conus arteriosus,** and is distinguished from the rest of the ventricular cavity by its walls being quite smooth and free from projections. At the commencement of the pulmonary artery are three small valvular folds, called **semilunar valves,** formed of endocardium, strengthened by a little fibrous tissue. They correspond in their posi-

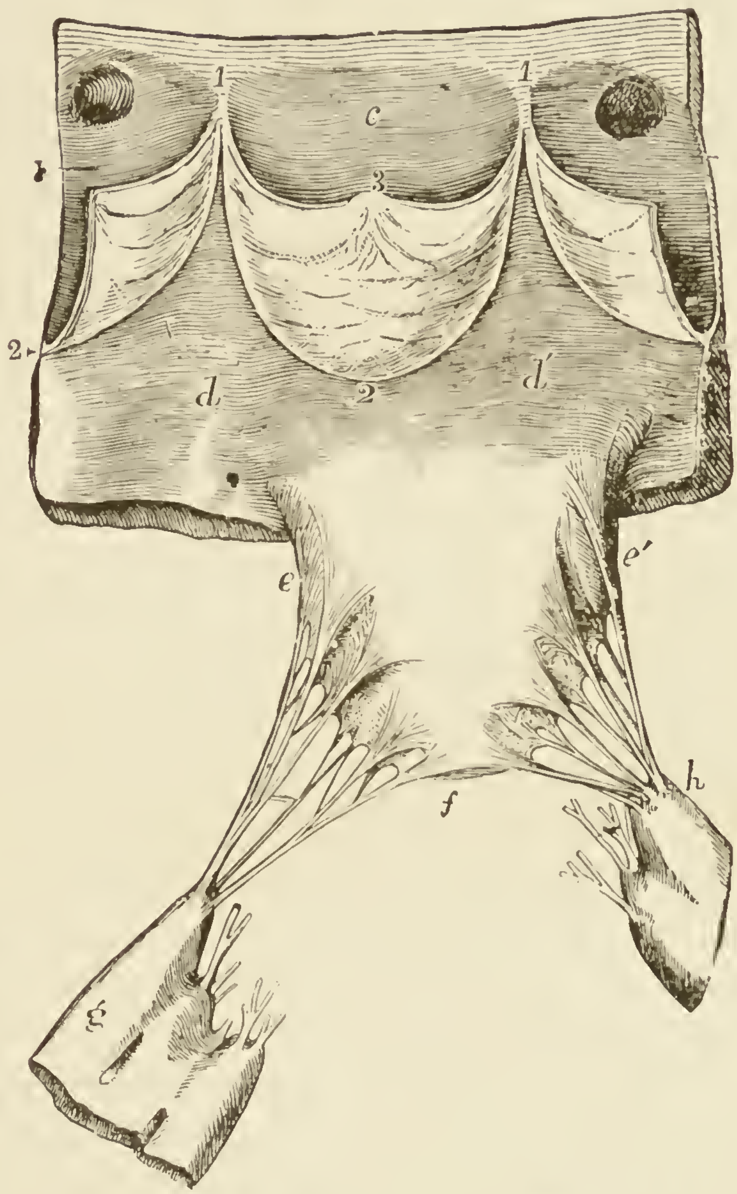


Fig. 83.—Portion of the wall of the right ventricle, *d*, *d′*, and aorta, *a*, *b*, *c*, showing attachment of one flap of the mitral and the aortic valves; *h* and *g*, musculi papillares; *e*, *e′*, *f*, attachment of chordæ tendineæ.

tion to slight pouches in the wall of the pulmonary artery (**sinuses of Valsalva**), and when closed they so completely shut off that vessel from the ventricle as entirely to prevent the blood returning to the heart. Thus they only permit the blood to pass in one direction, namely away from the heart.

The **Left Auricle** is situated at the back of the base of the heart. It has entering into it the four pulmonary veins.

The **Left Ventricle** much resembles the right, but its walls are much thicker, the muscular prominences are more marked, and the musculi papillares are more pronounced. The auriculo-ventricular valve has only two flaps, and is called **mitral**, from its supposed resemblance to a bishop's mitre. The conus arteriosus leads up to the commencement of the **aorta**, at the opening of which there are semilunar valves, similar to those in the pulmonary artery, but thicker and stronger. The recesses corresponding to the valves (sinuses of Valsalva) are distinct and large. In two of them there are openings forming the commencement of the coronary arteries—the vessels for the supply of the heart structure.[1]

Between the cavities of the two sides of the heart is a strong wall, formed of muscle, constituting the **septum**: it forms a complete division even in the child, but before the time of birth a communication exists between the two auricles by means of a large foramen through the auricular septum.

The **nerves** of the heart are derived from the vagus nerve and sympathetic; they are distributed beneath the pericardium on the surface of the organ, and have in their course numerous small ganglia.

ARTERIES.

Arteries are the vessels which carry the blood from the heart to the tissues; their structure has been already described (p. 25).

Aorta.—This is the great vessel which springs from the left

[1] The course of the circulation and the mode in which the valves act in directing the stream is not here described, as such details are physiological, not anatomical. The reader will find these matters fully discussed in the *Elementary Text-Book of Physiology*, by Dr. J. M'Gregor Robertson, published in the same series as the present work.

ventricle of the heart and forms the main trunk from which, directly or indirectly, all the systemic arteries are derived. At its origin from the heart it is on a level with the sixth dorsal vertebra, and there presents the three dilatations already mentioned, the **sinuses of Valsalva,** corresponding to the semilunar valves. It at first passes upwards and to the right, then curves backwards and to the left, and descends on the left side of the vertebral column to the body of the fourth lumbar vertebra, where it divides into two large trunks for the supply of the two lower extremities. It is divided into the arch of the aorta, the thoracic aorta, and the abdominal aorta.

The **Arch of the Aorta** has arising from its upper surface the three great arteries for the head and neck and the upper extremities, viz., going to the right side, the innominate artery, and going to the left, the left common carotid and left subclavian. Beneath the arch lie the pulmonary artery, the left bronchus, the recurrent branch of the left vagus nerve, and numerous nerves passing to the heart (cardiac plexus). In front it is covered by the left lung and pleura, left phrenic and vagus nerves, cardiac nerves going to the heart, and some veins.

The first branches given off from the arch are the **Coronary arteries**, for the supply of the structure of the heart itself. They are given off immediately above the semilunar valves, and run in the auriculo-ventricular and interventricular grooves on the surface of the organ, and divide into branches which are distributed to the muscular fibres.

The next branch is the **Innominate** (*nameless*), a large but short trunk passing upwards to the root of the neck, and dividing, behind the right sterno-clavicular joint, into the right common carotid and right subclavian arteries.

The **Right Common Carotid artery** passes up the neck, by the side of the wind-pipe and gullet, to a level with the upper part of the larynx (voice-box), where it divides into the external and internal carotid arteries. In the lower part of the neck it is deeply placed, and is covered by the sterno-mastoid and other muscles connected with the sternum; as it ascends it

comes nearer to the surface, and can be easily felt, and in thin persons can be seen pulsating. It gives off no branch but the two terminal ones mentioned.

The **Right Subclavian** forms an arch in the lower part of the neck and extends from the sterno-clavicular joint to the lower border of the first rib; it can be felt pulsating behind and a little above the clavicle, and can be easily compressed there against the first rib on which it lies. This is a ready and effective means of controlling bleeding from any part of the upper limb. Under the name of axillary it is continued into the arm-pit, and is the main vessel for the supply of blood to the arm. In its course it gives off the following important branches:—

a. Vertebral.
b. Internal Mammary.
c. Thyroid Axis.
d. Superior Intercostal.

The **Vertebral artery** is a very long branch, whose importance consists in the fact that it is one of the chief means by which the brain is supplied with blood. It passes up the neck in the foramina in the transverse processes of the cervical vertebræ (except the seventh), winds round the upper articular process of the atlas to reach the upper surface of the posterior arch of that bone, then enters the spinal canal by piercing the membranes, and passes up beside the medulla oblongata to the under surface of the brain. On reaching the back of the pons Varolii the arteries of the two sides unite to form a common trunk, the **basilar**, from which branches are given off to the brain, some of them uniting with arteries derived from the internal carotid to form a circle of arterial communication named the *circle of Willis.* In its course upwards the vertebral artery gives off branches to the spinal cord and muscles of the neck.

The **Basilar artery** formed by the union of the two vertebrals lies on the under surface of the pons Varolii, and at the front of that structure divides into four branches, two on each side; these are the two **superior cerebellar arteries** and the two

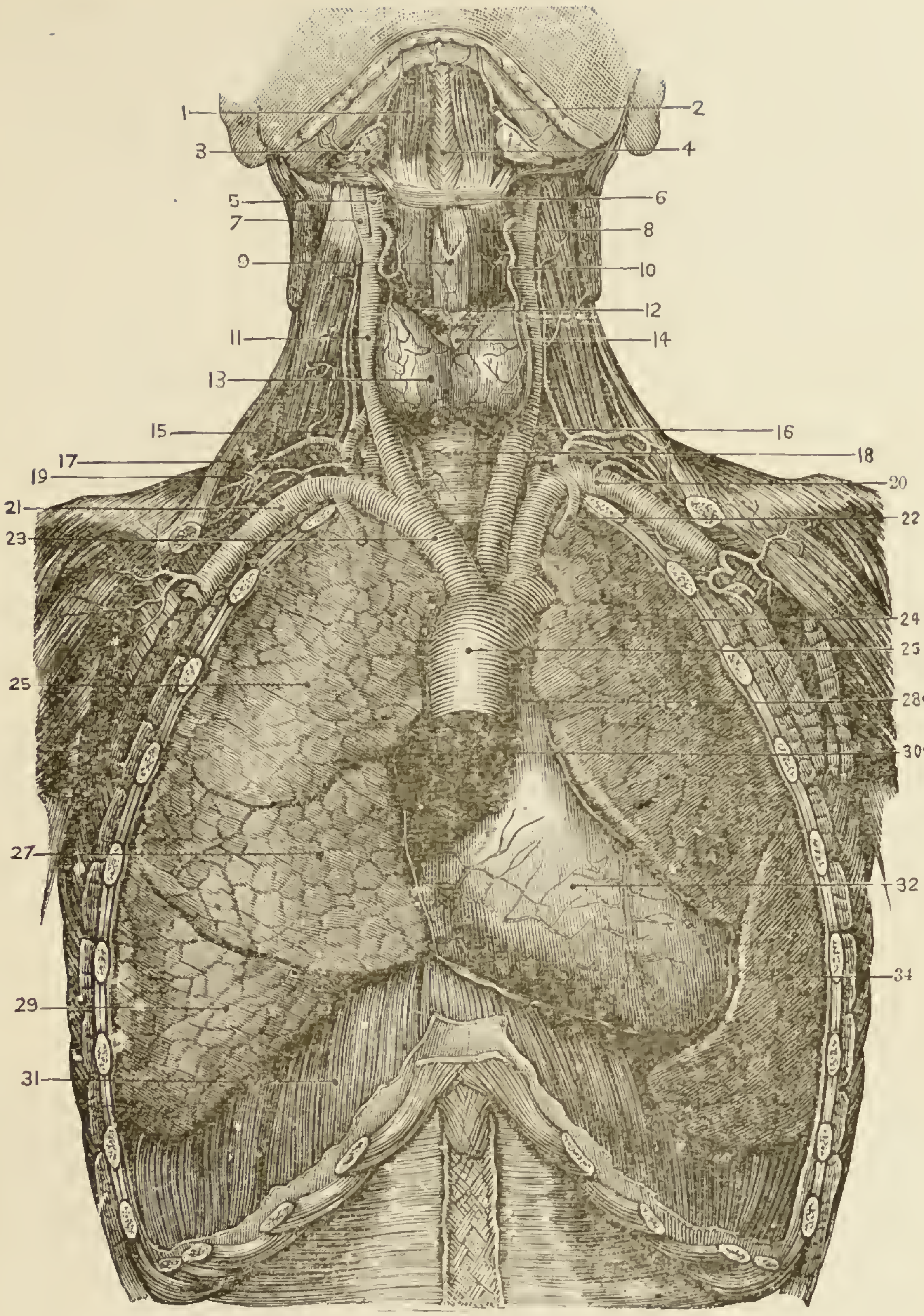


Fig. 84.—Heart and Great Vessels.

1, Digastric muscle; 2, submental artery; 3, submaxillary gland; 4, mylo-hyoid muscle; 5, external carotid artery; 6, hyoid bone; 7, internal carotid artery; 8, thyro-hyoid muscle; 9, thyroid cartilage; 10, superior thyroid artery; 11, right common carotid artery; 12, cricoid-thyroid muscle; 13, thyroid body; 14, cricoid cartilage; 15, inferior thyroid artery; 16, left common carotid; 17, thyroid-axis; 18, trachea; 19, vertebral artery; 20, left subclavian artery; 21, right subclavian; 22, internal mammary artery; 23, innominate artery; 24, upper lobe of left lung; 25, upper lobe of right lung; 26, arch of aorta; 27, middle lobe of right lung; 28, pulmonary artery; 29, lower lobe of right lung; 30, right auricle; 31, diaphragm; 32, right ventricle; 34, lower lobe of left lung. [Wilson.]

posterior cerebral arteries. Each posterior cerebral receives a small branch, the **posterior communicating** from the internal carotid, and in this way the circle of Willis is completed. The basilar gives off twigs to the pons, and a small branch to accompany the auditory nerve to the internal ear, and hence called **auditory artery.**

The **Internal Mammary artery** is also a very long branch; it descends on the inner surface of the chest wall, lying against the costal cartilages. When it reaches the diaphragm it divides into two terminal branches: one running along the line of attachment of the diaphragm to the ribs and supplying it (**musculo-phrenic**); and the other (**superior epigastric**) entering the sheath of rectus muscle of the abdomen to supply that muscle, and communicate with the deep epigastric branch of the external iliac artery. As the internal mammary descends it gives off branches to the intercostal spaces, pericardium, and other structures in the neighbourhood.

The **Thyroid Axis** is a short trunk which divides, immediately after its origin, into three branches. One of these, the **inferior thyroid**, passes behind the common carotid to reach the windpipe and gullet, to which, and to the thyroid body, it is distributed. The other two branches supply the lower part of the neck and the shoulder.

The **superior intercostal artery** supplies some of the muscles of the neck and the two upper intercostal spaces.

The second branch of the arch of the aorta is the **Left Common Carotid.** After passing upwards in the thorax for about one and a half inches, it runs behind the left sterno-clavicular joint, and from this point to its termination corresponds in every particular with its fellow of the opposite side. The only distinction between the right and left common carotid arteries is, therefore, that the former arises from the innominate artery, the latter from the arch of the aorta.

The **Left Subclavian artery** is the third branch of the arch of the aorta. It corresponds in every particular with the right artery, excepting that it arises from the arch instead of from the innominate, and is consequently about two inches longer.

Carotid Arteries.—Opposite the upper border of the chief cartilage of the larynx the common carotid divides into two branches, the external carotid and the internal carotid.

The **External Carotid** is really the more internal of the two at its commencement, but it gets its name from the fact that it is distributed to the external parts of the head and face. It

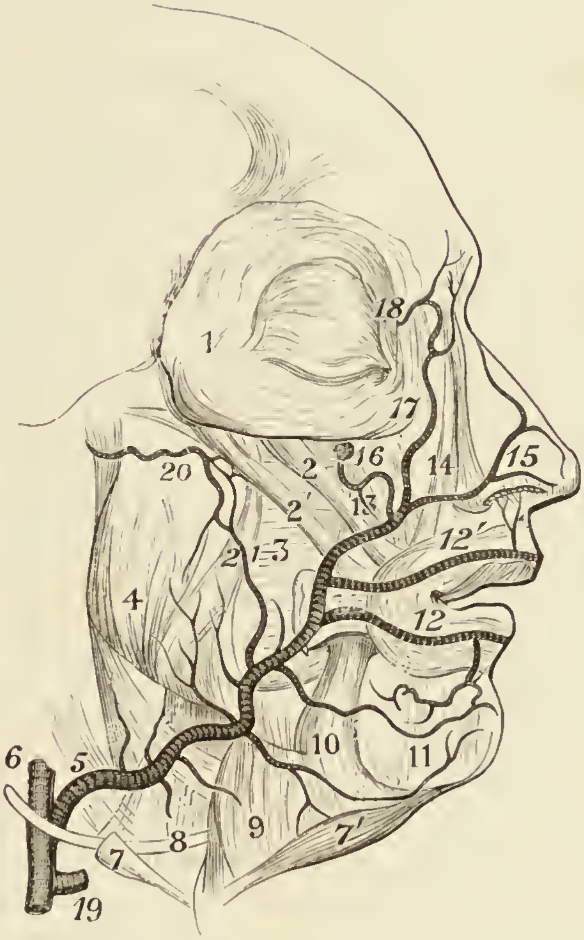


Fig. 85.—Distribution of Facial Artery.

1, Orbicularis palpebrarum; 2, zygomaticus minor; 2′, zygomaticus major; 3, buccinator; 4, masseter; 5, facial artery; 6, external carotid artery; 7, posterior belly of digastric; 7′, anterior belly; 8, hypoglossal nerve; 9, platysma; 10, depressor of angle of mouth; 11, inferior labial arteries; 12, inferior coronary; 12′, superior coronary; 13, facial and infraorbital branches communicating; 14, elevator of upper lip and ala of nose; 15, branches to nose; 16, infraorbital foramen; 17, angular artery; 18, communication with ophthalmic; 19, lingual artery; 20, transverse facial; 21, communication between facial and transverse facial. [Morris.]

passes upwards behind the ramus of the lower jaw, and ends in the substance of the parotid gland, by dividing into two terminal branches. The arteries derived from the external carotid are:—

a. Superior Thyroid.
b. Lingual.
c. Facial.
d. Occipital.
e. Posterior Auricular.
f. Superficial Temporal.
g. Internal Maxillary.
h. Ascending Pharyngeal.

The **Superior Thyroid artery** goes to the thyroid body, and the interior and exterior of the larynx.

The **Lingual artery** (as its name indicates) supplies the muscles which move the tongue, the substance of that organ itself, and in part the salivary glands.

The **Facial artery** winds round the lower jaw, a little in front of the angle, to reach the face; it runs up to the corner of the mouth, thence to the ala of the nose, and from there to the angle of the eye. It supplies the structures of the face with blood, and forms a free communication with arteries in the neighbourhood; as a consequence, the face has a very copious supply of blood, and bleeds very easily when injured.

The **Occipital** is a branch of considerable size going to the muscles of the neck and back of the head, and terminating in the scalp.

The **Posterior Auricular** is mainly distributed to the external ear.

The **Superficial Temporal**, one of the terminal branches, given off when the carotid is in the substance of the parotid gland, passes up to the side of the head in the temporal region, and there branches to be distributed to the scalp. This vessel is so superficial as to be readily felt pulsating, and in old persons often becomes tortuous and visible; it is the cause of the throbbing sensation in congestive headache.

The **Internal Maxillary artery** (also a terminal branch) passes inwards behind the neck of the lower jaw to reach the deep structures of the face. It is distributed to the muscles and nerves of mastication, the cavities of the face and nose, and the upper and lower teeth, forming numerous communications with the facial artery.

The **Pharyngeal** branch, as its name implies, goes to the muscles and other structures of the pharynx or food-bag.

Internal Carotid.—This artery lies to the outer side of the external carotid where they spring from the common carotid. It is dilated and a little tortuous at its origin, and runs up the neck, much more deeply situated than the external carotid, to the base of the skull, where it passes through a canal in the

petrous portion of the temporal bone to reach the cranial cavity. It gives off no branches in the neck. In the skull, its first large branch, the **ophthalmic**, goes to the eye-socket (orbit), distributing twigs to the eyeball, its muscles, the fat around the eye, the eyelids, tear gland, &c. The largest and most important branches of the internal carotid are given to the under-surface, front, and middle of the great brain (cerebrum); they

Fig. 86.—Arteries of Face and Side of Head.

1, Facial artery; 2, inferior labial; 2′, inferior coronary; 3, facial artery at angle of mouth; 4, superior coronary; 5, lateral nasal; 6, frontal branch of ophthalmic; 7, internal carotid; 8, external carotid; 9, division of external carotid into temporal and internal maxillary; 10, superficial temporal; 11, masseteric branch of external carotid: 12, internal maxillary; 13, 13, middle meningeal; 14, deep temporal; 15, pterygoid branches; 16, buccal branch; 17, superior dental; 18, branches of infra-orbital artery. [Quain, after Tiedemann.]

are the **anterior cerebral** going to the frontal lobes; the **middle cerebral (Sylvian)** going to the motor convolutions of the brain and to the great motor ganglionic mass at the base (corpus striatum); and the **posterior communicating** to unite with the posterior cerebral branch of the basilar.

Circle of Willis.—This is a peculiar arterial circle, situated at the base of the brain, and so arranged as to ensure an uninterrupted and copious supply of blood to that important organ. In front the two **anterior cerebral arteries** lie in the longitudinal fissure of the brain, and are there connected by a small transverse branch, the **anterior communicating**. Behind, the basilar gives off the two **posterior cerebral arteries**,

and these are connected with the internal carotid by means of the **posterior communicating** branches of that artery. The circle is therefore formed in the following manner:—

Anterior Communicating.	
Anterior Cerebral.	Anterior Cerebral.
Internal Carotid.	Internal Carotid.
Posterior Communicating.	Posterior Communicating.
Posterior Cerebral.	Posterior Cerebral.
Basilar.	

It will be noted that four main trunks go to the brain;

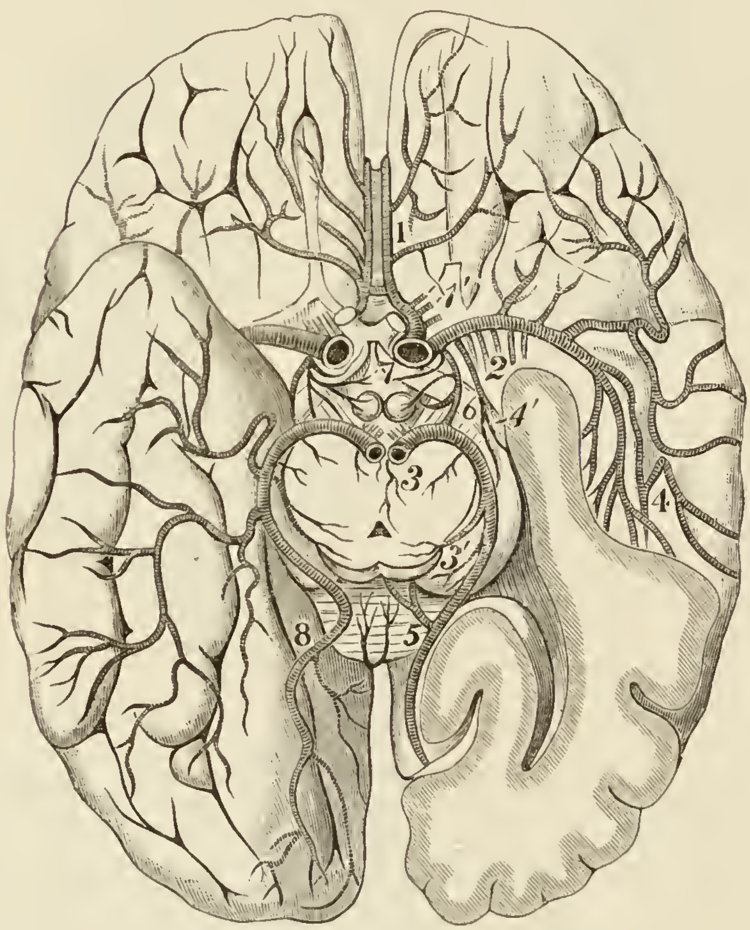


Fig. 87.—Base of Brain, showing the chief arteries (medulla, pons, and cerebellum removed).

1, Anterior cerebral artery —the arteries of the two sides of the brain are seen to be connected by a small transverse branch, the anterior communicating; 1', branches to the interior of the brain; 2, middle cerebral artery; 3, posterior cereral artery; 3', branches to interior of brain; 4, branches of middle cerebral distributed to *island of Reil*; 5, branches to occipital lobe; 4', choroidal branch; 6, posterior communicating; 7, internal carotid; 8, branch of posterior cerebral to inner surface of hemisphere. [Quain.]

namely, the two vertebral arteries and the two internal carotids, and that they very freely communicate both from before backwards and from side to side in the Circle of Willis. The branches of these trunks distributed to the convolutions of the brain have, on the contrary, a very different disposition, for they do not communicate with each other, but are **terminal** or **end arteries**, which accounts for the serious paralysis which ensues when a branch becomes plugged with a blood-clot.

Arteries of the Upper Limb.—The **Axillary artery** is the continuation of the subclavian. It runs down on the outer side of the cavity of the armpit to the arm, where it again changes its name and becomes brachial. At the lower part of the cavity of the armpit, where it emerges from under cover of the pectoral muscles, the axillary artery is quite superficial and can be compressed against the head and upper part of the shaft of the humerus. The branches given off from this vessel are distributed to the muscles forming the walls of the cavity of the armpit, and the glands and fat contained in it. The largest of them lies on the front of the scapula, and is therefore called **subscapular.**

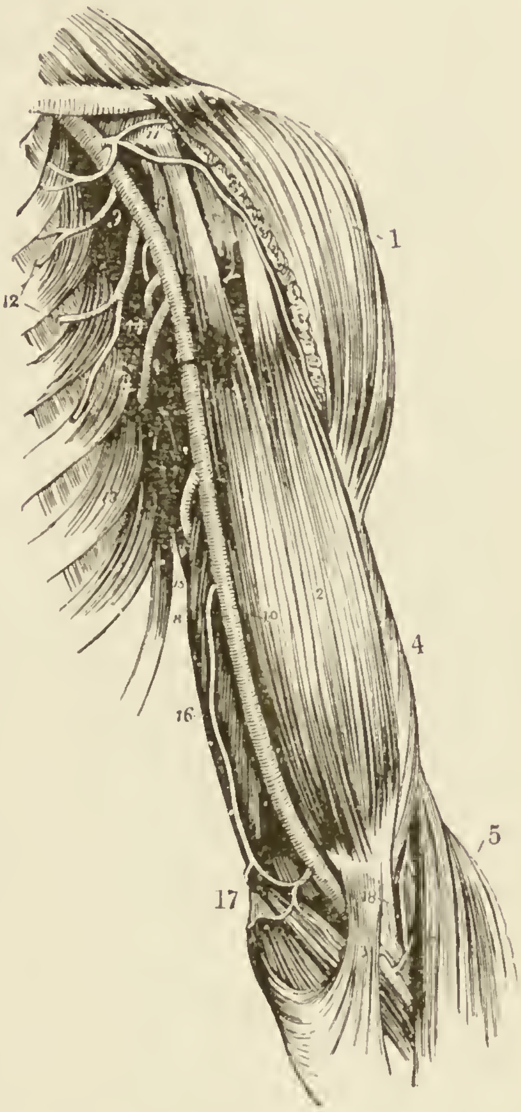


Fig. 88.—Axillary and Brachial Arteries, with their branches.

1, Deltoid; 2, biceps; 3, bicipital fascia; 4, brachialis anticus; 5, supinator longus; 6, coraco-brachialis; 7, 8, triceps; 9, axillary artery; 10, brachial artery; 11, 12, branches to the pectoral muscles and chest wall; 13, serratus magnus; 14, subscapular artery; 15, superior profunda; 16, inferior profunda; 17, anastomotic branch; 18, termination of superior profunda. [Wilson.]

The **Brachial artery** is the continuation of the axillary. In its course down the arm it lies to the inner side of the biceps muscle, and is placed at no great distance from the surface. It terminates at the bend of the elbow, where it divides into radial and ulnar arteries. In the upper third of the arm it lies very close to the bone and can be compressed against it; this is a convenient means of arresting bleeding in wounds of the hand or forearm. The branches of the brachial are superior profunda, inferior profunda, anastomotica magna, nutrient, and muscular. The **superior profunda** winds round the back of the humerus along with the musculo-spiral nerve, in the

shallow groove on the bone, and communicates at the outer side of the front of the elbow with a branch of the radial artery. The **inferior profunda** passes directly downwards along with the ulna nerve to the back of the internal condyle of the humerus, giving off branches to muscles in its course, and communicating with the ulnar artery. The **anastomotica magna,** given off just above the elbow-joint, sends twigs to the brachialis anticus and the muscles arising from the internal condyle, and communicates with the inferior profunda, and the radial and ulnar arteries. The **nutrient** branch goes to the humerus to supply that bone, and the **muscular** branches are distributed to the muscles of the upper arm.

The radial and ulnar arteries are formed by the bifurcation of the brachial at the bend of the elbow.

The **Radial artery** passes down the outer side of the front of the forearm, and is not very deep in any part of its course. At the wrist it becomes quite superficial, and can be felt beating between the tendons of the long supinator muscle and the radial flexor of the carpus, in which situation its beat is spoken of as "the pulse". On reaching the wrist the radial artery turns round to the back of the hand, and, running through the interosseous muscle between the metacarpal bones of the thumb and index-finger, reaches the deep part of the palm of the hand. Here it runs transversely across the base of the metacarpal bones, forming the **deep palmar arch**—which is completed by a branch of the ulnar artery. The branches of the radial artery are (1) a **recurrent** branch, which runs upwards in front of the elbow to unite with the superior profunda; (2) branches to the muscles and other structures on the front of the forearm; (3) a branch to join the ulnar in the palm of the hand and complete the superficial palmar arch **(superficial volar)**; (4) twigs to the wrist-joint; the one on the back of the hand is of large size, and gives branches to the interosseous spaces of the hand; (5) branches to the back of thumb and index-finger; (6) a large branch to the front of the thumb; (7) a branch to the outer side of the index-finger; (8) deep branches to the palm of the hand and to the fingers.

The **Ulnar artery** is at first placed very deeply beneath the mass of muscles arising from the internal condyle of the humerus, but as it runs down the inner side of the front of the forearm it becomes more superficial, and immediately above

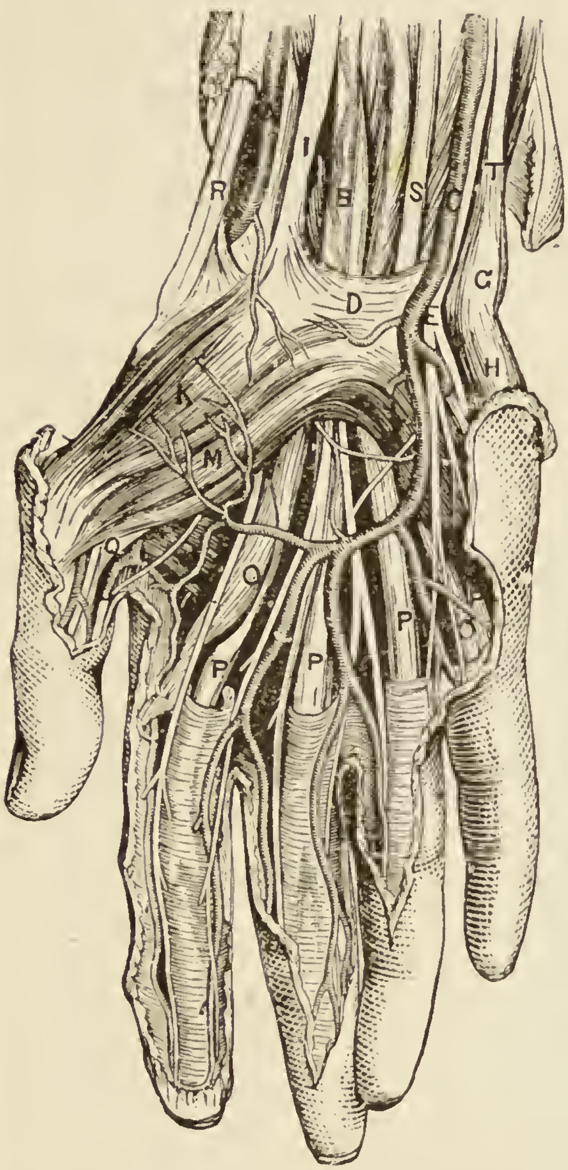


Fig. 89.—Superficial Arteries of Hand.

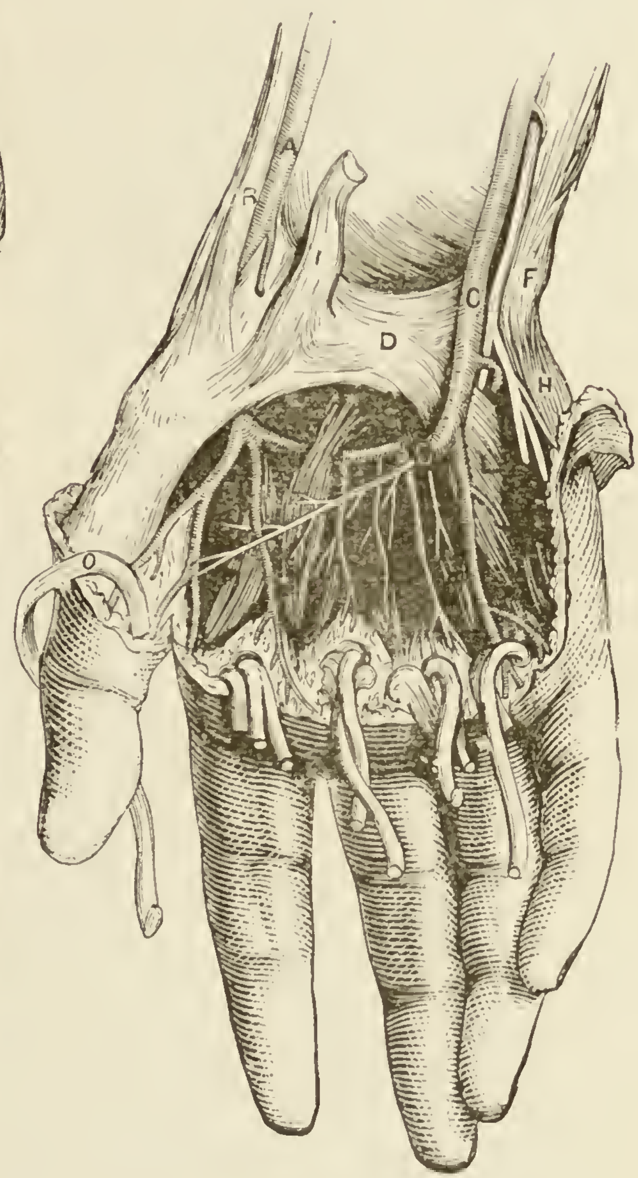


Fig. 90.—Deep Arteries of Hand.

A, Radial artery; B, median nerve; C, ulnar artery; D, anterior annular ligament; E, ulnar nerve; F, insertion of ulnar carpal flexor; G, pisiform; H, abductor of little finger; I, tendon of radial carpal flexor; K, abductor of thumb; L, flexor of little finger; M, short flexor of thumb; O, lumbricales; P, flexor tendons; Q, tendon of long flexor of thumb; R, supinator longus; S, superficial flexor; T, ulnar carpal flexor. [Wilson.]

the wrist can be felt between the inner tendon of the superficial flexor and that of the ulnar flexor of the carpus. Even here, however, it is to some extent overlapped by the muscles, and is not so distinctly in evidence as the radial artery. It next enters the palm of the hand by crossing over the annular

ligament, covered only by the palmar fascia, and forms the **superficial palmar arch,** which terminates at the outer side of the palm by a communicating branch from the radial. The **superficial palmar arch** lies upon the nerves and tendons passing to the fingers, and gives off branches to the tendons, skin, fat, and fascia of the hand, and digital branches to all the fingers excepting the thumb and the outer side of the index-finger. The **digital branches** run one on each side of the finger, and at the front of the last digit, where the pulp of the finger is situated, they form an arch by joining together, and give off twigs to the back of the digit to supply the matrix of the nail. Soon after its origin from the brachial the ulnar artery gives off a considerable branch, the **interosseous,** which at once divides into an **anterior** and **posterior** branch. The former runs down on the front of the interosseous membrane; the latter passes between the bones of the forearm to the back, and there is placed between the superficial and deep layer of muscles. Immediately on entering the hand, and before forming the palmar arch, the ulnar gives off a deep palmar branch to supply the muscles of the little finger and assist the radial in the formation of the deep arch.

It will thus be seen that there are two arterial arches in the palm of the hand; the **superficial palmar arch** lying between the skin and the tendons, and formed by the ulnar artery with a branch from the radial; the **deep palmar arch** lying between the tendons and the metacarpal bones, and formed by the radial artery, with a branch from the ulnar.

Thoracic Aorta.—The thoracic aorta passes down the chest, lying upon the left side of the dorsal vertebræ, being continuous with the arch of the aorta at the body of the fifth. At the lower part of the chest it runs a little forwards, and ends by passing through an opening in the diaphragm opposite the twelfth dorsal vertebra to become the abdominal aorta.

The branches of the thoracic aorta are all comparatively small. It gives off twigs to the pericardial sac, the bronchial tubes, gullet, and the packing tissues of the chest. The largest

and most important branches are the **intercostal**; there are commonly nine pairs of these, the two upper spaces on each side being supplied by the superior intercostal branch of the subclavian. They run in the intercostal spaces between the external and internal intercostal muscles, and are distributed to the structures forming the chest wall.

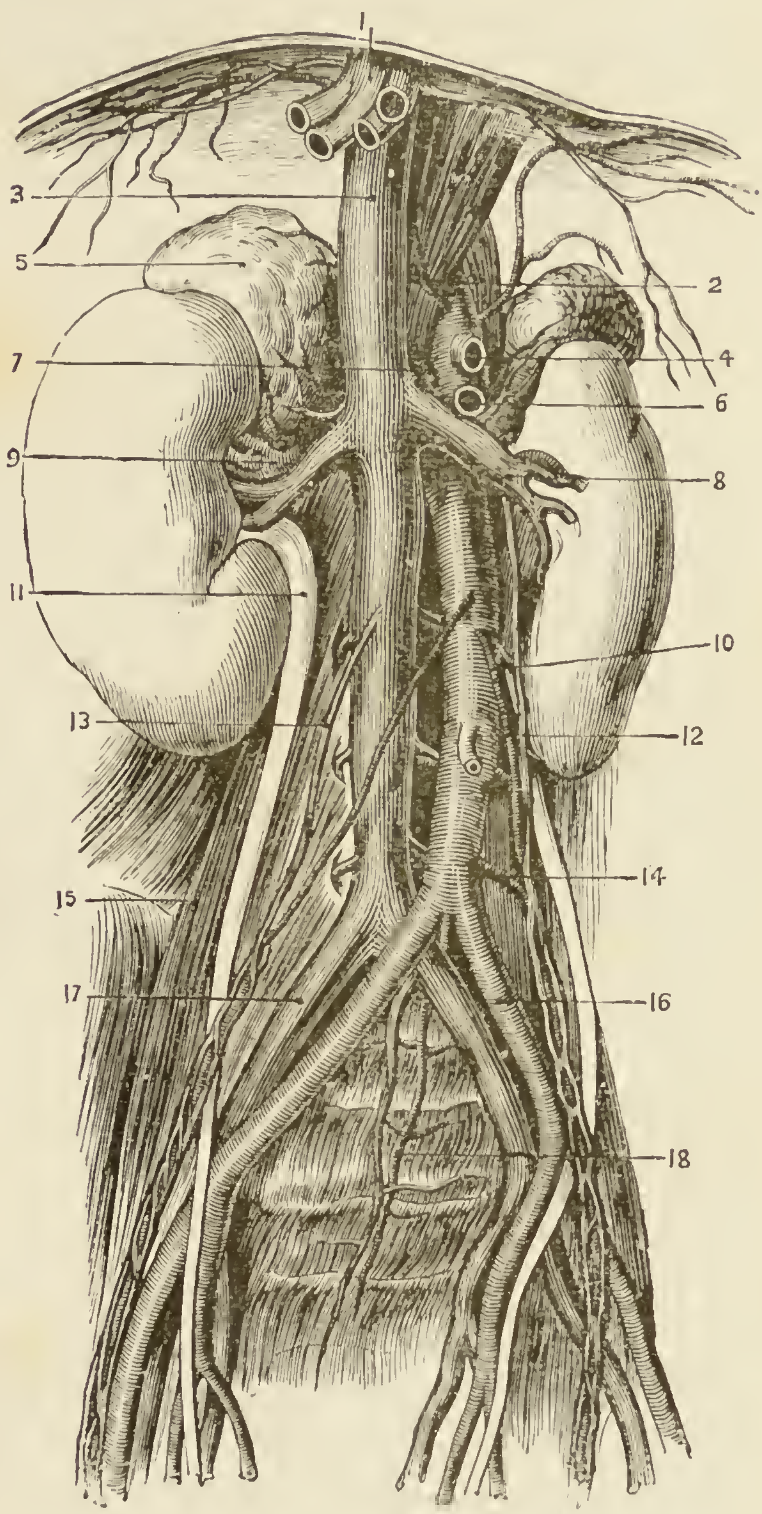


Fig. 91.—Abdominal Aorta and Inferior Vena Cava.

1, Hepatic veins (cut); 2, phrenic arteries; 3, vena cava; 4, cœliac axis (cut); 5, supra-renal body; 6, superior mesenteric artery (cut); 7, supra-renal artery; 8, renal vein; 9, renal artery; 10, left spermatic vessels; 11, right ureter; 12, inferior mesenteric artery; 13, right spermatic vein; 14, a lumbar artery; 15, psoas muscle; 16, left common iliac artery; 17, right common iliac vein; 18, middle sacral artery. [Wilson.]

Abdominal Aorta.—The aorta enters the abdomen by passing through an opening in the diaphragm, and extends from the body of the twelfth dorsal vertebra to that of the fourth lumbar, where it divides into the right and left common iliac arteries. Its point of bifurcation is situated below and a little to the left of the navel. The branches it gives off are for the supply of the viscera, posterior part of the abdominal wall, and lower part of the spinal canal. They are as follows:—

a. Phrenic (for the diaphragm).
b. Cœliac axis dividing into
  - Gastric (stomach).
  - Hepatic (liver).
  - Splenic (spleen and pancreas).

c. Superior Mesenteric (small intestines).
d. Inferior Mesenteric (large intestines).
e. Spermatic (testicle or ovary).
f. Supra-renal (supra-renal body).
g. Renal (kidney).
h. Lumbar (muscles and spinal canal).

The branches to the stomach and intestines form very free communications with each other, so that from the gullet down to the anus there are a series of anastomotic circles. In this way provision is made for the supply of blood so necessary for actively carrying on the processes of digestion and absorption, and the communications ensure that the supply shall not be stopped, even although some of the vessels are temporarily obliterated by pressure or from any other cause. The quantity of blood contained in the vessels of the abdomen is at all times large, but is greater during digestion than during fasting.

The **Phrenic arteries** supply the under surface of the diaphragm.

The **Cœliac axis** is a short trunk springing from the front of the aorta immediately after it reaches the abdomen. It is surrounded by an extensive plexus of nerves (chiefly sympathetic), called the **solar plexus**, and divides at once into three branches—gastric, hepatic, splenic. The **gastric artery** runs along the upper border of the stomach and joins a small branch from the hepatic, the two together forming an arch. The **hepatic**, after giving off branches to the pancreas, upper part of the small intestines, lower border of the stomach, and the gall-bladder, passes into the transverse fissure of the liver, and divides into branches to supply the structure of that organ. The **splenic** is a large and very tortuous artery, placed behind the stomach and along the upper border of the pancreas. It gives branches to the lower margin of the stomach, the pancreas, and spleen.

The **Mesenteric arteries** supply the whole of the intestines,

the **superior** going to the small bowel and half the large, the **inferior** supplying the remaining half of the large intestine. Fig. 92 shows the beautiful triple arches formed by the communications of the branches of the superior mesenteric arteries in the mesentery.

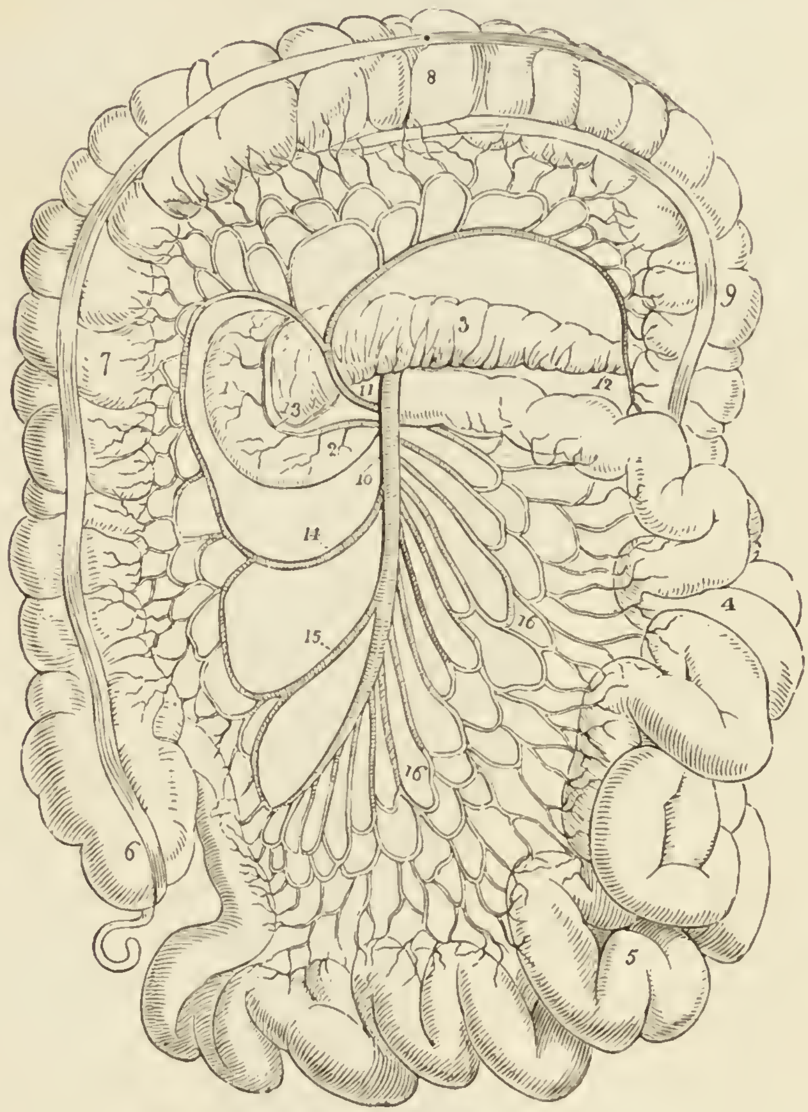


Fig. 92.—Superior Mesenteric Artery and Branches.

1, Descending part of duodenum; 2, transverse part; 3, pancreas; 4, jejunum; 5, ileum; 6, cæcum; 7, ascending colon; 8, transverse colon; 9, descending colon; 10, superior mesenteric artery; 11, middle colic branch; 12, branch going to join left colic; 13, branch to pancreas and duodenum; 14, right colic; 15, ilio-colic branch; 16, branches to small intestines. [Wilson.]

The **Spermatic arteries** are very small but exceedingly long branches springing from the front of the abdominal aorta, nearly as high up as the level of the kidneys. They run down the back wall of the abdomen to the inguinal canals, passing through which, along with the ducts of the testicles, they form part of the spermatic cords, and end by being distributed to the testicles and the structures surrounding them. In the female they are called **ovarian arteries,** and do not pass through the abdominal wall, but into the pelvis, where they enter the broad ligaments of the uterus to reach the ovaries. The reason why these arteries arise so high up from the abdominal aorta is because both the testicle and ovary are originally formed immediately beneath the kidneys, and get their blood from

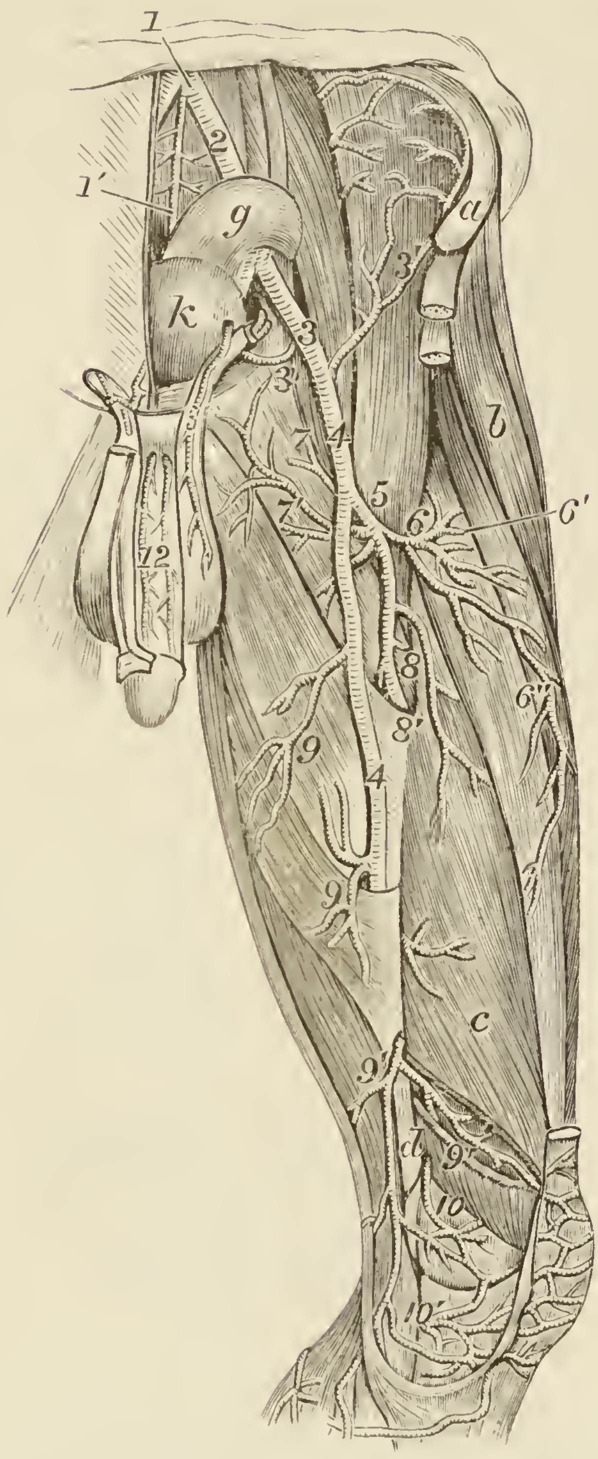


Fig. 93.—Arteries of the Thigh.

a, Anterior superior iliac spine; *b*, tensor fasciæ femoris muscle; *c*, vastus internus; *d*, tendon of great adductor; *g*, termination of colon; *k*, urinary bladder; 1, bifurcation of aorta; 1′, middle sacral artery; 2, left common iliac; 3, external iliac; 3′, circumflex iliac branch; 3″, deep epigastric; 4, femoral; 5, deep femoral; 6, external circumflex; 6′ and 6″, ascending and descending branches; 7 and 7′, internal circumflex; 8 and 8′, perforating branches; 9, muscular branches; 9′, anastomatic branch; 10 and 10′, articular branches; 12, arteries of the penis. [Quain after Tiedemann.]

what is then the nearest main trunk. In the later months of intra-uterine life those organs travel down to the position they are to permanently occupy, and the arteries elongate as they descend.

The **Supra-renal arteries** supply the supra-renal bodies—peculiar structures placed at the upper end of the kidneys, whose use is not well understood.

The **Renal arteries** are large vessels going to the kidneys. They are larger than the renal veins.

The **Lumbar arteries** (four in number) supply the psoas and quadratus lumborum muscles and other muscles of the back. They also give off branches to the spinal canal to supply the membranes of the spinal cord, the lower end of the cord itself, and the large nerves derived from it.

The **Common Iliac arteries** are the great trunks formed by the division of the abdominal aorta. They are usually about two inches in length, give off no branches in their course, and end by dividing into the external and internal iliac arteries.

The **External Iliac artery** of each side runs downwards and outwards along the brim of the pelvis to the groin, where it passes beneath Poupart's ligament and becomes femoral. At its termination it can easily be compressed against the pelvic bone, and this is the readiest and most effective means of stopping bleeding from a wound in the thigh or leg. The point where the pressure is to be applied is about the middle of Poupart's ligament. The only branches derived from the external iliac are the deep epigastric and the deep circumflex iliac, both of them given off just as the artery is about to pass into the thigh. The **deep epigastric** runs upwards and inwards to reach the sheath of the rectus muscle, in which it ascends, supplying the rectus and the aponeurosis of the abdomen, and forming a communication with the superior epigastric branch of the internal mammary. The **deep circumflex iliac** runs outwards, and is distributed to the outer part of the abdominal wall and iliac fossa.

The **Internal Iliac** passes downwards, from the point of its origin, to the outer wall of the pelvic cavity, where it divides into a great number of branches, of which the following are the chief:—

a. Superior and inferior vesical (for the urinary bladder).
b. Middle Hæmorrhoidal (for the rectum, the termination of the large intestine).
c. Uterine and Vaginal (in the female).
d. Obturator.
e. Ischiatic.
f. Internal Pudic.
g. Gluteal.
h. Ilio-lumbar.
i. Sacral.

The branches going to the pelvic viscera enumerated above do not call for any special description.

The **Obturator artery** passes through the upper part of the obturator foramen in the pelvis to the muscles of the inside of the thigh—the adductor group—to which it is distributed, forming communications with branches of the femoral and ischiatic arteries. It gives branches also to the hip-joint.

The **Ischiatic** passes through the great sacro-sciatic foramen to reach the buttock. Its branches for the most part end in the great gluteal muscle, but some pass to other muscles in the neighbourhood, and one accompanies the great sciatic nerve and supplies it with blood.

The **Internal Pudic artery** passes out of the pelvis through the great sciatic foramen along with the veins and nerve of the

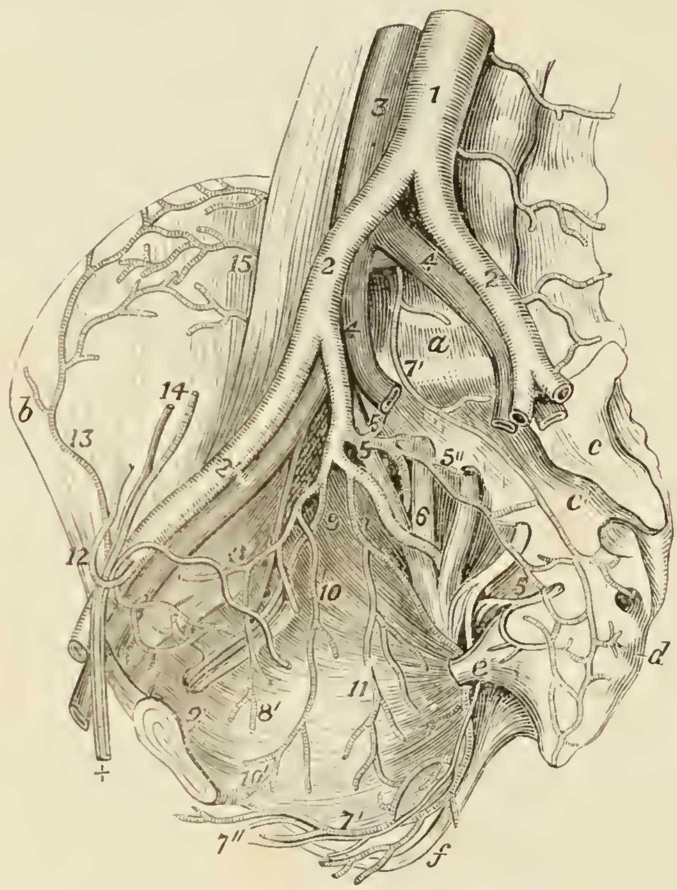


Fig. 94.—External and Internal Iliac Arteries.

a, Body of fifth lumbar vertebra; *b*, anterior superior spine of ilium; *c*, sacrum; *d*, coccyx; *e*, lesser sacro-sciatic ligament; *f*, tuberosity of ischium; *g*, opening for obtusator vessels; 1, abdominal aorta; 2, common iliac artery: 2′, external iliac; 3, inferior vena cava; 4, common iliac veins; 5, posterior branches of the internal iliac; 6, sacral nerves; 7, 7′, and 7″, pudic artery and its branches; 8, remains of umbilical artery; 8′, branches to the bladder; 9, obturator artery; 10, vesical branches, to base of bladder; 11, branches to rectum; 12, deep epigastric; 13, deep circumflex iliac; 14, spermatic; 15, ilio-lumbar. [Allen Thomson.]

same name. It then crosses the spine of the ischium and re-enters the pelvis through the lesser sciatic foramen. It runs on the inside of the ramus of the ischium to the perineum, to the structures of which it is distributed.

The **Gluteal artery** leaves the pelvic cavity through the great sciatic foramen, and is distributed to the lesser and least gluteal muscles and the tensor of the fascia of the thigh.

The **Ilio-lumbar** is in place of a fifth lumbar artery. It runs in the back part of the iliac fossa, and communicates with the lumbar branches of the abdominal aorta.

The **Sacral branches** pass to the sides and front of the sacrum.

The **Femoral artery** is the continuation of the external iliac into the thigh. It forms a thick, short trunk, which, after giving off a few small branches, divides into two, the superficial femoral and the deep femoral.

The **Superficial Femoral artery** takes its course along the inside of the thigh, its general direction being indicated by a line drawn from the middle of Poupart's ligament to the inner side of the knee. It is not very deeply placed, and can be felt pulsating along this line. It can be compressed by a tourniquet or bandage and pad, but is not sufficiently near the bone for pressure with the fingers to be effective. At about five inches above the knee the artery enters a canal formed by tendons and fasciæ, called **Hunter's canal.** This space it occupies with its companion vein and a small nerve (long saphenous); at the lower end of the canal it passes through an opening in the great adductor muscle, and reaching the cavity at the back of the knee-joint—the popliteal space—changes its name and becomes the popliteal artery. It gives off no important branches in its course. The **deep femoral (profunda artery)** goes downwards and backwards among the muscles of the thigh, and breaks up into branches for the great mass of muscles forming the bulk of the thigh. The branches are named (1) **external circumflex**, (2) **internal circumflex**, and (3) **perforating.** They form communications with each other, with the branches of the internal iliac, and with arteries coming from below the knee, and by this arrangement are able to efficiently supply the leg, even although the superficial femoral is ligatured or otherwise obliterated. The **perforating branches** are so called because they pass through the adductors to reach the muscles on the back of the thigh (ham-string muscles).

The **Popliteal Space** is the deep hollow found at the back of the knee when the leg is semiflexed. Its lateral boundaries are the inner and outer ham-strings. Its floor is formed by the triangular area at the back of the lower end of the femur, and the posterior ligament of the knee-joint. It is traversed by the popliteal artery and vein and the two popliteal nerves. It also contains lymphatic glands and a considerable quantity of fat.

The **Popliteal artery** is the continuation of the superficial femoral. It commences at the opening in the great adductor which forms the termination of Hunter's canal, and terminates about three inches below the knee by dividing into anterior and posterior tibial arteries. The branches it gives off are distributed to the knee-joint (5) and to the muscles of the calf (3 or 4).

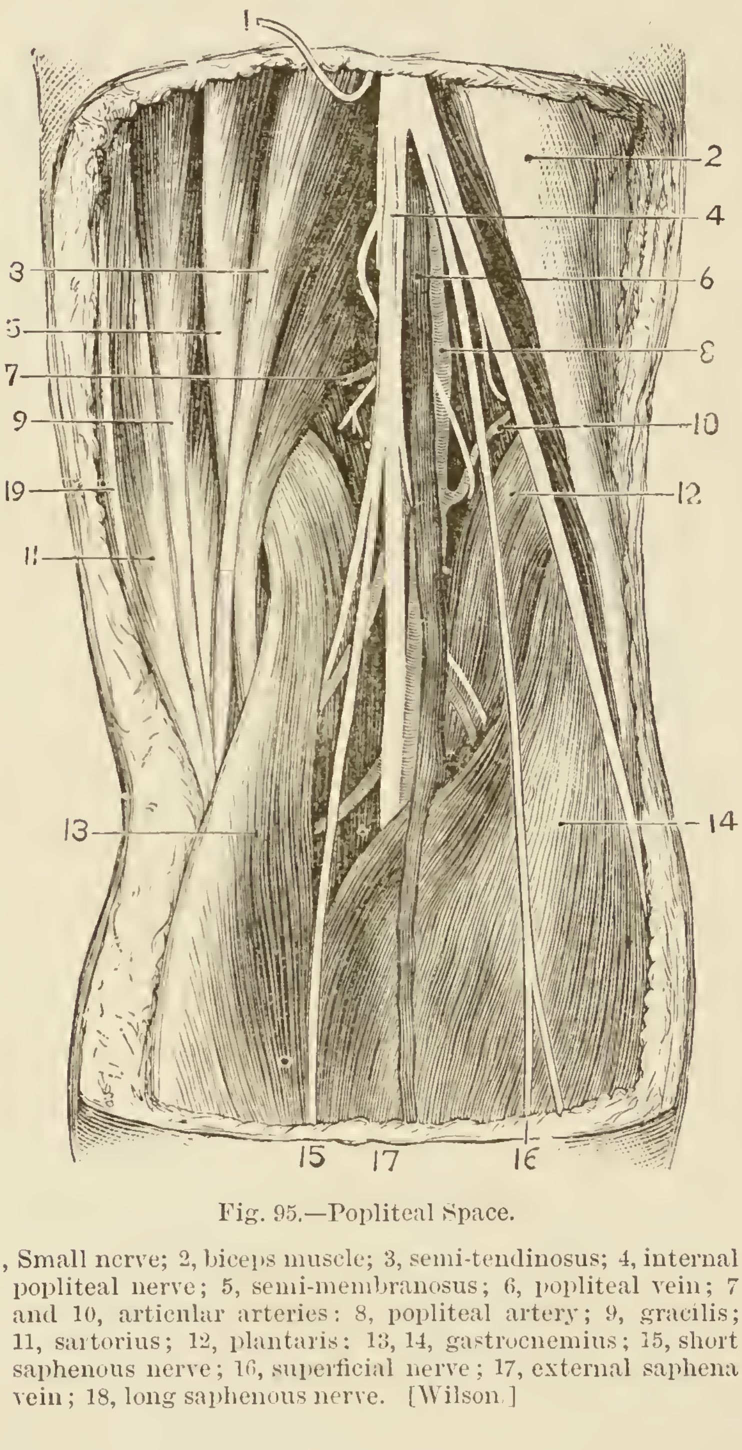


Fig. 95.—Popliteal Space.

1, Small nerve; 2, biceps muscle; 3, semi-tendinosus; 4, internal popliteal nerve; 5, semi-membranosus; 6, popliteal vein; 7 and 10, articular arteries; 8, popliteal artery; 9, gracilis; 11, sartorius; 12, plantaris; 13, 14, gastrocnemius; 15, short saphenous nerve; 16, superficial nerve; 17, external saphena vein; 18, long saphenous nerve. [Wilson.]

The **Anterior Tibial artery,** one of the divisions of the popliteal, passes forwards between the tibia and fibula to the front of the limb. It then passes down on the anterior surface of the interosseous membrane to the front of the ankle-joint, being covered by the muscles which lie on the outer surface of the tibia. It gives off branches to the muscles in its neighbourhood, and one which passes upwards to the knee-joint (**tibial recurrent**). After the artery has crossed the ankle it changes its name, and is called the **dorsal artery of the foot.** Under that title it gives branches to the tarsus and metatarsus, to the muscles and tendons on the back of the foot, and to the sides of the toes on their dorsal aspect. It passes between the

big and second toes and supplies their under surface, ending by joining the termination of the external plantar artery at the inner end of the plantar arch.

The **Posterior Tibial artery** passes down the back of the leg between the superficial and deep muscles, to which it gives off numerous twigs, and reaching the inner ankle turns round it to reach the sole of the foot. Soon after its origin it gives rise to a considerable branch, the **peroneal**, for the supply of the muscles covering the fibula and the structures in connection therewith.

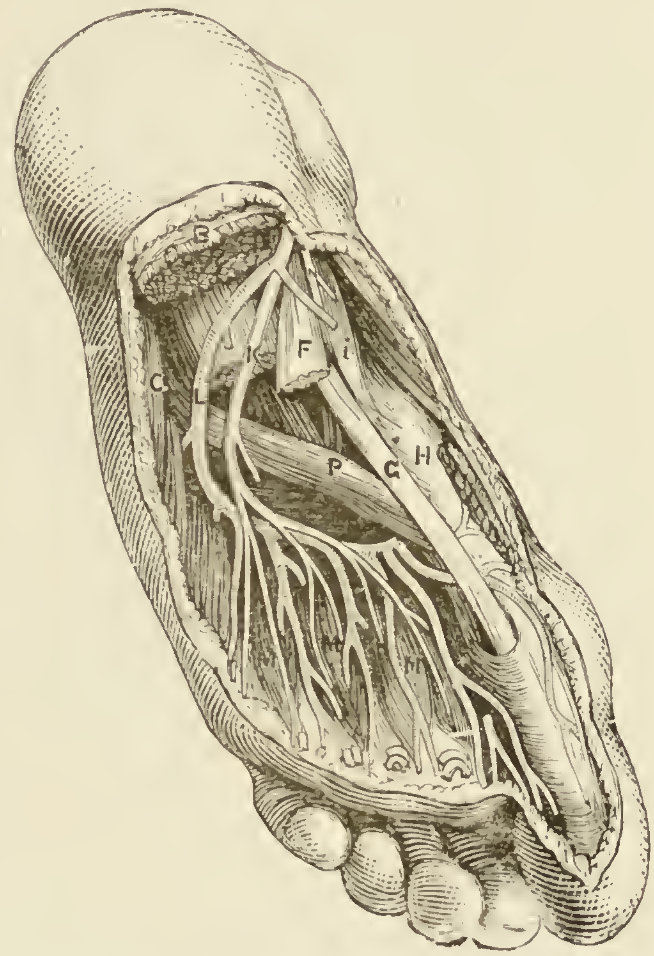


Fig. 96.—Arteries of Sole of Foot.

B, Plantar fascia; C, abductor of little toe; F, long flexor muscle; G, flexor of big toe; H, metatarsal bone of big toe; *i*, tendon of tibialis posticus; K, external plantar nerve; L, external plantar artery; M, interosseous muscles; P, tendon of peroneus longus. [Wilson.]

On reaching the sole of the foot the posterior tibial divides into two branches, the **internal** and **external plantar**. The **internal plantar** is very small, and merely supplies the inner side of the foot and the muscles of the big toe. The **external plantar artery** is of considerable size; it passes outwards between the first and second layer of muscles of the foot, and then turns inwards again between the second and third layers, to reach the interval between the big toe and second toe, where it is joined by the termination of the dorsal artery of the foot. In the second part of the course it forms the **plantar arch**, and from it are given off digital branches. These pass to the toes, and are arranged in the same manner as the corresponding branches distributed to the fingers.

Pulmonary Artery.—This vessel carries venous blood to the lungs, but it is called an artery because it carries blood *from the heart.* It springs from the left side of the base of the right ventricle, in front of the origin of the aorta, ascends obliquely towards the left, and passes underneath the arch of the aorta, where it divides into two trunks, one for the right and the other for the left lung. These enter the lungs between the bronchi and the pulmonary veins. At its commencement the pulmonary artery is guarded by the semilunar valves, as already described; they prevent the blood passing back into the right ventricle.

VEINS.

The veins are vessels which carry the venous blood back from the capillaries to the heart. They are larger, more numerous, and form more frequent intercommunications than the arteries. The veins form two systems, the superficial and the deep; the former lie immediately beneath the skin, and the latter accompany the arteries among the muscles.

Veins of the Head and Neck.—These are divisible into three sets; the veins of the head and face, the veins of the skull, and the veins of the neck.

Veins of the Head and Face.—The **Facial vein** commences by small branches upon the forehead and front of the scalp; these unite to form two channels which communicate at the root of the nose; each branch then passes by the side of the nose, round the outer side of the mouth, and downwards to the edge of the lower jaw, just in front of the masseter muscle, receiving numerous branches and communications in its course. Underneath the jaw the facial vein terminates in the internal jugular. The **Internal Maxillary** and **Temporal veins** run with the arteries of the same name. They join together in the parotid gland to form a common trunk (**Temporo-maxillary**) lodged in the substance of the gland; this divides lower down into two branches, one of which joins with the posterior auricular to form the external jugular, and the other ends in the internal jugular.

The **Posterior Auricular** and **Occipital veins** run with the arteries of the same name.

Veins of the Skull.—Some of these are situated in the substance of the bones of the skull, and are named **veins of the diploe**; the largest and most important are placed in the interior of the skull, and are called **sinuses of the brain.**

The **sinuses** receive the blood from the surface and interior of the brain. They differ from ordinary veins because they have no valves, and the current of blood is therefore free to travel in either direction. They have no muscular structure in their walls, but the latter are formed by the outer membrane of the brain (the dura mater), supported in most cases by the bones, and lying in grooves on their surface. Omitting those of little importance, the following may be enumerated:—

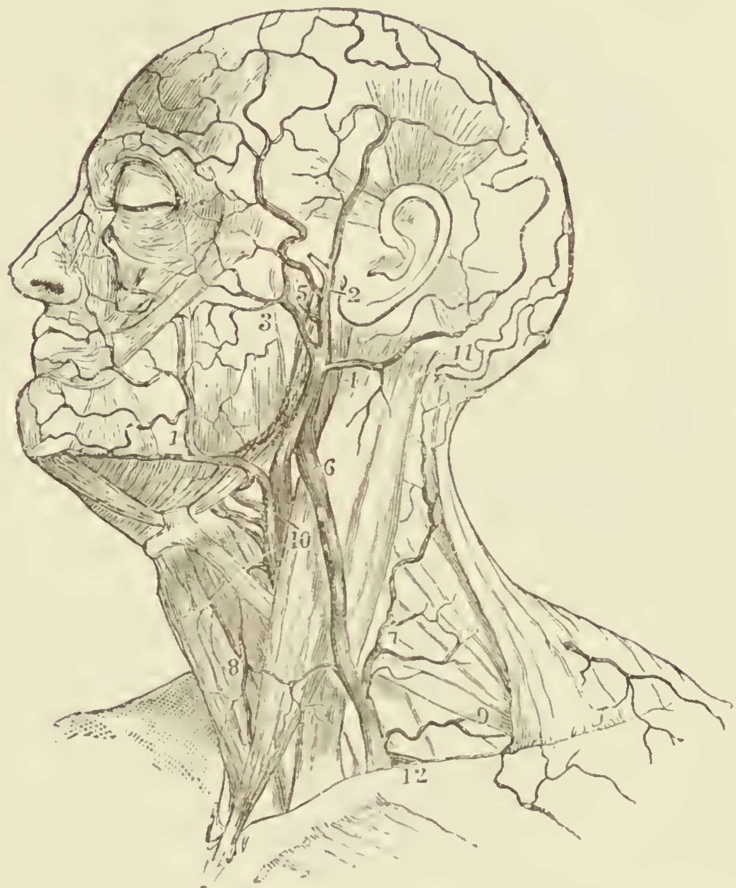


Fig. 97.—Veins of the Head and Neck.

1, Facial; 2, temporal; 3, transverse facial; 4, posterior auricular; 5, internal maxillary; 6, external jugular; 7, branch joining the latter; 8, anterior jugular; 9, posterior scapular; 10, internal jugular; 11, occipital; 12, subclavian.

Superior Longitudinal Sinus, running from before backwards along the middle line of the interior of the skull, and receiving the blood from the upper surface of the brain.

Inferior Longitudinal Sinus, contained in the edge of a sickle-shaped process of dura mater (the falx cerebri), and receiving the veins from the inner surface of the brain.

Two **cavernous sinuses**, formed by the veins from the eye-socket (orbit), and placed on the sides of the body of the sphenoid bone

A **straight sinus**, formed by the confluence of the veins from the interior of the brain and the inferior longitudinal sinus.

Two **Lateral sinuses** (the largest of the sinuses), running in grooves on the occipital, parietal, and temporal bones, and terminating by joining with the petrosal sinuses in the formation of the internal jugular veins. In descending to the jugular foramen the lateral sinus occupies an especially deep groove in the mastoid portion of the temporal bone. Attention is called to this fact, because injuries to the mastoid have sometimes been the cause of fatal bleeding from the sinus, and it has also been opened into in the course of operations on that bone.

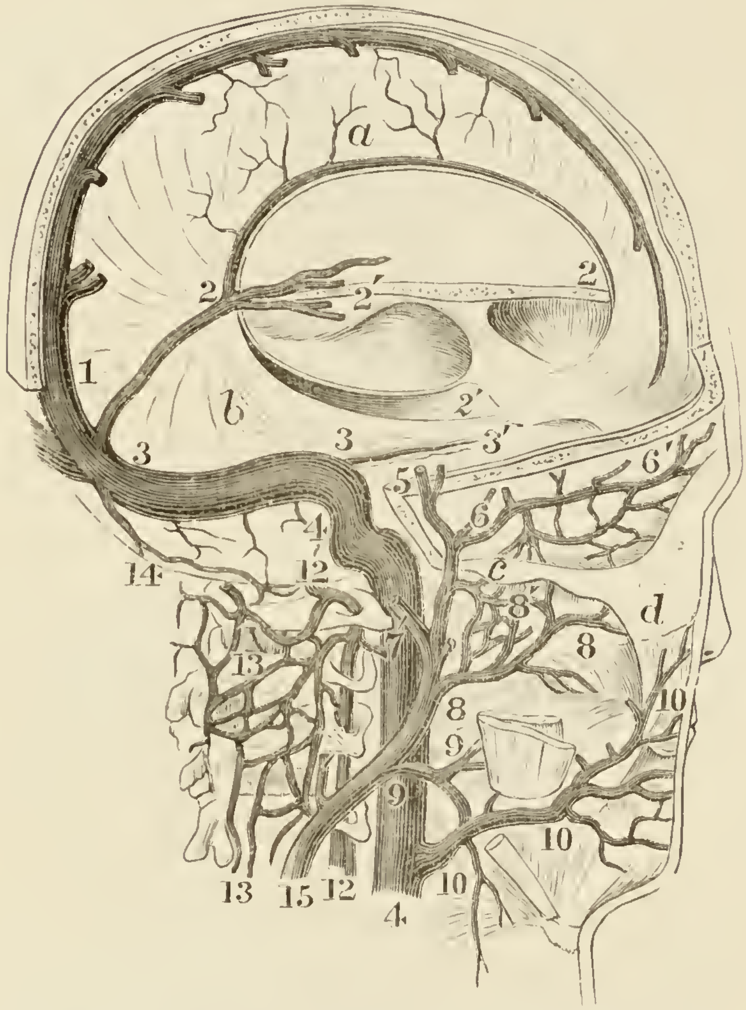


Fig. 98.—Sinuses of Brain and Veins of Head and Neck.

a, Falx cerebri; *b*, tentorium cerebelli; *c*, zygoma; *d*, malar bone; 1, superior longitudinal sinus; 2, inferior longitudinal sinus; 2′, veins of Galen, continued into straight sinus; 3, lateral sinus; 4, internal jugular vein; 5, 6, temporal veins; 8, internal maxillary; 8′, pterygoid plexus; 9, temporo maxillary; 10, facial vein; 12, vertebral; 13, posterior spinal; 14, occipital sinus; 15, external jugular. [Quain.]

Four **Petrosal sinuses**, two large and two small. The **inferior petrosal sinuses** are vessels of considerable size which carry the blood away from the cavernous sinuses. They unite with the lateral sinuses to form the internal jugular veins.

Veins of the Neck.—These are the three jugular veins—anterior, external, and internal—and the vertebral veins.

The **Anterior Jugular veins** run down the front of the neck and empty into the subclavian or the external jugular veins.

The **External Jugular** is formed, at the lower border of the parotid gland, by the junction of the posterior auricular vein with one of the divisions of the temporo-maxillary. It crosses the sterno-mastoid muscle to the lower part of the neck, and piercing the deep fascia joins the subclavian vein opposite the middle of the clavicle. This vein is generally visible beneath the skin. In the days when venesection was practised it was often selected for that operation, especially in apoplexy and head injuries.

The **Internal Jugular**, formed by the convergence of the lateral and inferior petrosal sinuses at the jugular foramen, is the largest vein of the neck. It passes downwards in the carotid sheath, lying to the outer side of the common carotid artery, and joins the subclavian to form the innominate vein.

The **Vertebral vein** runs along with the vertebral artery in the foramina of the transverse processes of the cervical vertebræ, and empties itself into the subclavian vein close to its termination.

Veins of the Upper Limb.—These are deep and superficial. Most of the deep veins are arranged in pairs, one on each side of the corresponding artery, and are called **venæ comites** (companion veins). As they correspond exactly to the arteries in name and distribution we shall not further describe them.

The superficial veins of the arm are:—

a. Two Ulnar veins.
b. Basilic vein.
c. Radial vein.
d. Cephalic vein.
e. Median vein.
f. Median-basilic.
g. Median-cephalic.

The **Ulnar veins** (anterior and posterior) collect the blood from the back of the hand and the inner side of the forearm; they unite at the bend of the elbow to form the basilic vein.

The **Basilic vein** runs along the inner side of the upper arm, receives the median-basilic soon after its commencement, and at the lower part of the armpit joins with the companion veins of the brachial artery to form the axillary vein.

The **Radial vein** commences on the back of the hand, winds round the outer side of the forearm as it ascends, and at the bend of the elbow unites with the median-cephalic vein to form the cephalic vein.

The **Cephalic vein** ascends along the outer side of the arm to its upper third, it then runs in the groove between the great pectoral muscle and the deltoid, and dipping deeply down ends in the upper part of the axillary vein.

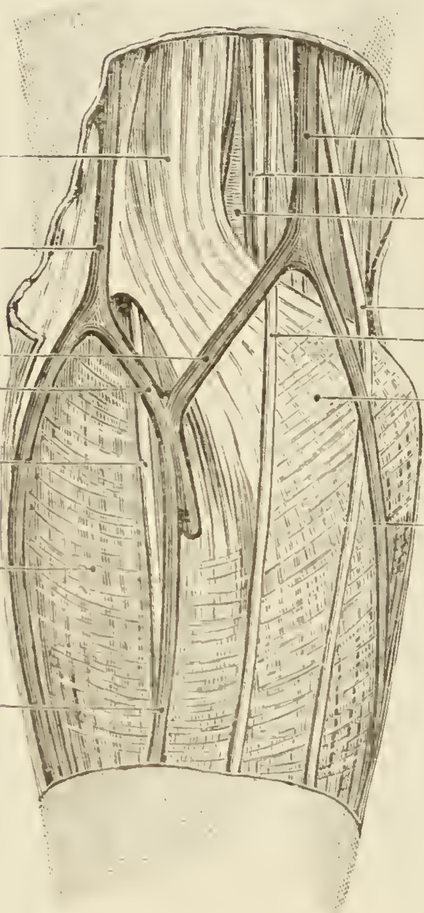


Fig. 99.—Superficial Veins in Front of the Elbow.

1, Biceps; 2, semilunar fascia; 3, anterior ulnar vein; 4, median nerve; 5, brachial artery; 6, internal cutaneous nerve; 7, radial vein; 8, median vein; 9, external cutaneous nerve; 10, median-cephalic vein; 11, median-basilic vein; 12, basilic vein; 13, cephalic vein. [Bardeleben and Haeckel.]

The **Median vein** lies between the radial and ulnar veins on the front of the forearm, and collects the blood from the palm of the hand and anterior aspect of the forearm. A little below the elbow it receives a branch from the deep veins, and then divides into two diverging branches, the median-cephalic and median-basilic.

The **Median-cephalic**, the longer and smaller of the two, passes obliquely upwards and outwards to unite with the radial and form the cephalic vein.

The **Median-basilic**, larger but shorter than the median cephalic, passes obliquely upwards and inwards to join the basilic vein. It is crossed by one or two cutaneous nerves.

When venesection from the arm was practised, one of these two veins was invariably selected. The median basilic, as the largest, gave more free bleeding than the other, but the brachial artery lies immediately behind it, and was frequently cut into by the lancet penetrating too deeply.

The **Axillary vein**, formed by the union of the basilic veins and the brachial companion veins, lies to the inner side of the

axillary artery, receives veins corresponding to the branches of the artery, and terminates at the lower border of the first rib by becoming subclavian.

The **Subclavian vein** is below and a little in front of the subclavian artery; where the latter lies on the first rib the vein is separated from it by the anterior scalene muscle. It receives the external jugular, anterior jugular, and vertebral veins, and ends by joining with the internal jugular to form the innominate vein. At the junction of these veins on the left side the thoracic duct empties; this is the great main trunk of the lymphatic system, which carries the products of digestion into the circulation. The right lymphatic duct, a much smaller vessel, opens into the corresponding veins of the right side.

Veins of the Lower Limb.—Like the veins of the upper extremity these are divided into superficial and deep.

The **Superficial veins** are the external or short and the internal or long saphena veins. They commence on the back of the foot in a venous arch, which lies across the metatarsus and receives the veins from the back of the toes.

The **External Saphena vein** commences at the outer border of the venous arch, passes behind the outer ankle, and runs up the back of the calf of the leg to the popliteal space, to join the popliteal vein.

The **Internal** or **long Saphena vein** is the longest vein in the body. It commences on the inner border of the foot by branches received from the venous arch, runs round the inner ankle, and ascends the inner side of the leg. It passes behind the inner condyle of the femur and along the inner side of the thigh to the saphenous opening, an oval aperture in the fascia lata a little below Poupart's ligament; here it terminates in the femoral vein. It has many valves in its course, but, from its great length and the liability to its current being interrupted at the knee and the saphenous opening, it is the most liable of any vein to become dilated and varicose. Varicose ulcers are most common in the region of its distribution, especially on the front and inner side of the lower leg.

The **deep veins** of the leg accompany the arteries and are

called by the same name. There are two veins for each artery (one on either side), excepting in the case of the popliteal, superficial femoral, and deep femoral (profunda) arteries, where the veins are single.

Veins of the Trunk.—The **Innominate veins** are two large trunks, formed by the union of the internal jugular and subclavian veins at each side of the root of the neck. The right one descends almost vertically into the thorax; the left passes obliquely downwards and towards the right, crossing the three great branches of the arch of the aorta, and is much longer than the right. The two join together about three inches above the base of the heart to form the superior vena cava.

The **Superior vena cava** is a large trunk about three inches in length, formed by the union of the two innominate veins. It passes down on the right side of the arch of the aorta, and, entering the pericardium, ends in the upper part of the right auricle. In addition to the innominate veins, it receives branches from the pericardium, and a trunk of considerable size from the back wall of the chest (**vena azygos major**).

The **External Iliac vein** is the continuation of the femoral vein into the trunk. It passes from the middle of Poupart's ligament upwards along the brim of the pelvis, and terminates opposite the union of the sacrum and ilium by uniting with the internal iliac vein to form the common iliac vein.

The **Internal Iliac vein** is formed by vessels corresponding with the branches of the internal iliac artery; it lies on the outer wall of the pelvis, and joins the external to form the common iliac vein. The more important veins terminating in the internal iliac are, in the male, the vesical, prostatic, and hæmorrhoidal veins from the bladder, prostate gland, and lower bowel; and in the female the vesical, hæmorrhoidal, and uterine.

The **Common Iliac veins** are formed by the union of the external and internal iliac veins. The two common iliac veins of the two sides join together on the intervertebral substance between the fourth and fifth lumbar vertebræ to form the inferior vena cava.

The **Inferior Vena Cava** is a very large trunk, lying on the

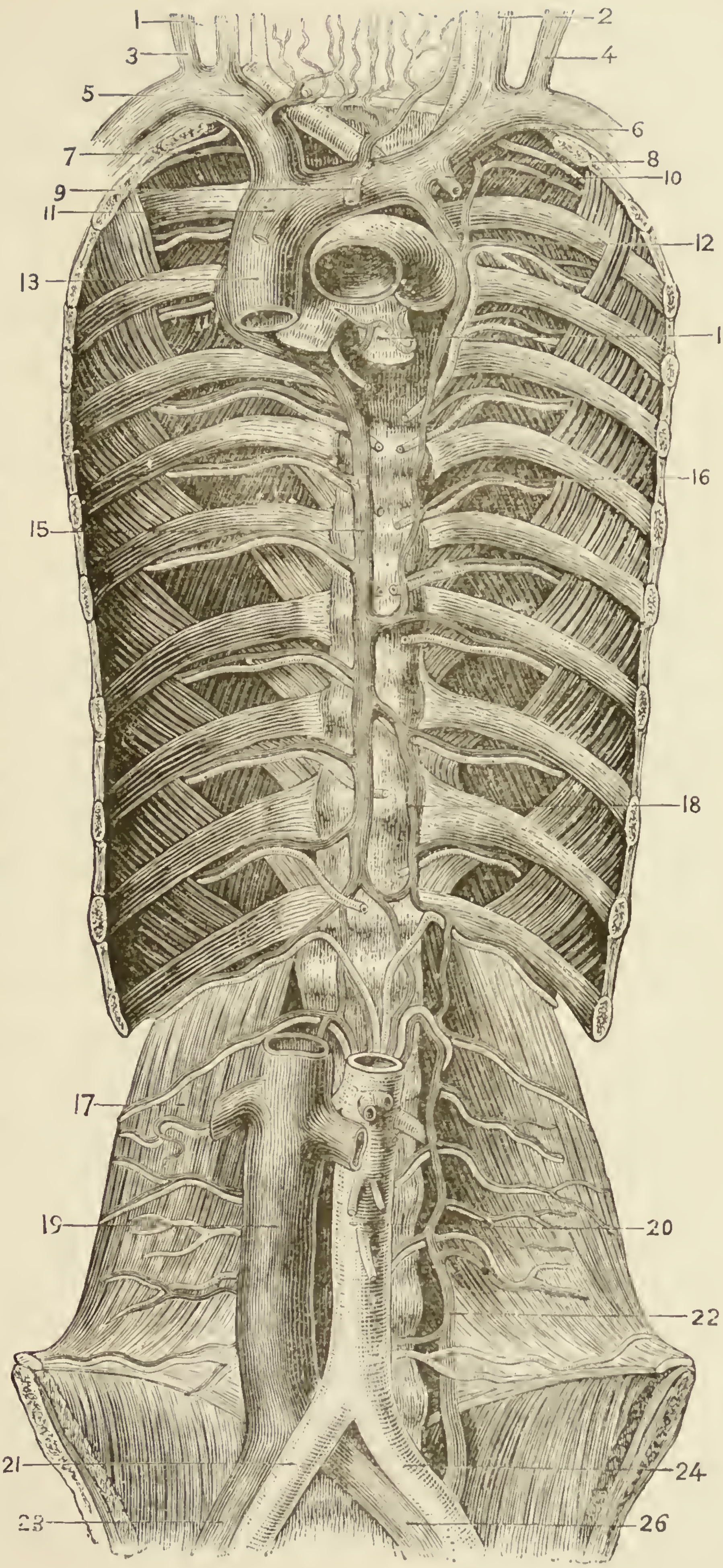


Fig. 100.—Veins of the Trunk.

1, Right internal jugular; 2, left internal jugular; 3, right external jugular; 4, left external jugular; 5, right innominate; 6, left innominate; 7, right superior intercostal; 8 and 12, left superior intercostal; 9, thymic; 10, left internal mammary; 11, pericardial; 13, vena cava superior; 14, left bronchus; 15, vena azygos major; 16 and 18, vena azygos minor; 17, quadratus lumborum muscle; 19, vena cava inferior; 20, abdominal aorta; 21, right common iliac artery; 22, lumbar vein; 23, right common iliac vein; 24, left common iliac artery; 25, left common iliac vein. [Wilson.]

left side of the abdominal aorta against the posterior wall of the abdomen. At the upper part of the abdomen it lies in close contact with the liver, and is often entirely surrounded by the substance of that organ; it then passes through an opening in the tendon of the diaphragm and reaches the cavity of the chest, where it terminates in the lower and back part of the right auricle of the heart.

The tributaries it receives may be enumerated as follows:—

a. Lumbar (abdominal wall).
b. Right Spermatic (testicle or ovary).
c. Renal (kidney).
d. Supra-renal (supra-renal body).
e. Diaphragmatic.
f. Hepatic (liver).

The **Lumbar veins** return the blood from the posterior wall of the abdomen and the lower part of the spinal canal; those of the left side pass behind the abdominal aorta to reach the inferior cava.

The **Right Spermatic vein**, from the right testicle, empties into the inferior cava, the **left** into the left renal vein. The **Ovarian veins** in the female occupy the same position, and terminate in the same way as the spermatic in the male.

The **Left Renal vein** is much longer than the right. It receives the blood from the left supra-renal body and the left testicle or ovary, as well as from the kidney, and passes across the front of the aorta to reach the vena cava.

The **veins of the liver** have no course outside the substance of that organ. They empty into the inferior cava as it lies in contact with the liver.

Veins are distributed in the intercostal spaces and back of the chest wall, in the spinal canal and vertebræ, and in the substance of the heart; but they are not of sufficient importance to justify a special description in this work.

Portal System.—The **portal system of veins** includes those of the spleen, stomach, large and small intestines, and pancreas. The vessels of this system differ from other veins in the following points:—(1) they have no valves; (2) they commence in

capillaries and end in capillaries; and (3) their muscular coat is much thicker than in veins usually. The blood of the portal system is carried to the liver by the portal vein, there to supply material for the manufacture of bile; it is returned by the hepatic veins into the inferior cava.

The vessels which empty their blood into the portal vein are the

a. Inferior Mesenteric vein.
b. Superior Mesenteric vein.
c. Splenic vein.
d. Gastric veins.

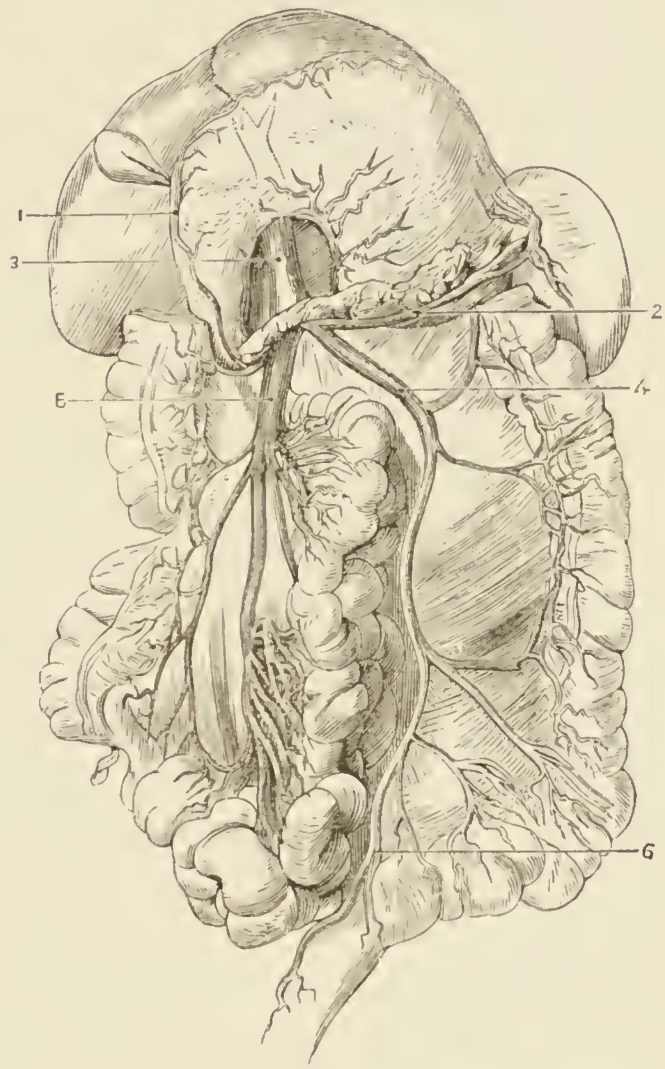


Fig. 101.—The Portal Vein and its Tributaries.

1, Vein from stomach and duodenum; 2, splenic vein; 3, portal vein; 4, inferior mesenteric vein; 5, superior mesenteric vein; 6, superior hæmorrhoidal vein.

The **Inferior Mesenteric vein** corresponds in its course with the artery of the same name. It ends in the splenic vein.

The **Superior Mesenteric,** in like manner, accompanies the superior mesenteric artery, and collects the blood from the whole of the small intestines and half the large. It joins with the splenic vein, behind the pancreas, to form the portal vein.

The **Splenic vein** is a large trunk carrying the blood from the spleen, pancreas, and great end of the stomach. It unites with the superior mesenteric to form the portal vein.

The branches from the stomach (**gastric**) empty directly into the portal vein.

The **Portal vein,** formed behind the pancreas by the union of the superior mesenteric and splenic veins, passes up to the under surface of the liver along with the bile duct and hepatic

artery. It enters the liver at the transverse fissure, and divides into branches, which, from their being surrounded by a continuation of the fibrous capsule of the liver, are described as lying in the **portal canals.**

Pulmonary Veins.—The four pulmonary veins (two from each lung) return the purified blood to the left auricle of the heart. They commence in the capillaries in the walls of the air-cells, accompany the bronchial tubes through the lung, and at the root are placed in front of the other structures forming it. They differ from veins generally in being smaller than the arteries corresponding to them, in carrying arterial instead of venous blood, and in having no valves.

LYMPHATICS.

The structure of lymphatic vessels and glands has been already described (p. 27). The vessels are divisible into three sets, viz. superficial, deep, and lacteals.

The **superficial lymphatic vessels** lie in the superficial fascia beneath the skin, and follow the course of the veins. They are, however, much more numerous than the latter, and have many more valves. They terminate in glands placed at the flexures of the limbs, as in the groin, popliteal space, and armpit.

The **deep lymphatic vessels** are less numerous, but rather larger. They accompany the deep veins and arteries, and are connected with the glands of the pelvis, the posterior wall of the abdomen, and the deep parts of the neck.

The **Lacteals** (so called because, during digestion, they carry a milk fluid, the *chyle*) are the lymphatics of the small intestine. They are situated in the mesentery, and are connected with numerous glands placed therein, and called the **mesenteric glands.** During fasting the lacteals carry transparent lymph like the other lymphatic vessels.

Lymphatics of the Head and Neck.—The **superficial lymphatic vessels** are arranged in three sets—**occipital,** running with the occipital vein; **temporal,** with the superficial temporal vein; and **facial,** with the facial vein.

Glands.—The chief glands are the following:—(1) **Occipital,** over the lateral part of the occipital bone; (2) **posterior auricular,** behind the ear; (3) **parotid,** a little in front of the ear; (4) **submaxillary,** below the jaw.

Deep lymphatic vessels are found in the skull, but there are no glands in their course.

The **superficial** and **deep lymphatic vessels of the neck** run with the radicles and main trunks of the jugular veins, and very freely communicate with each other.

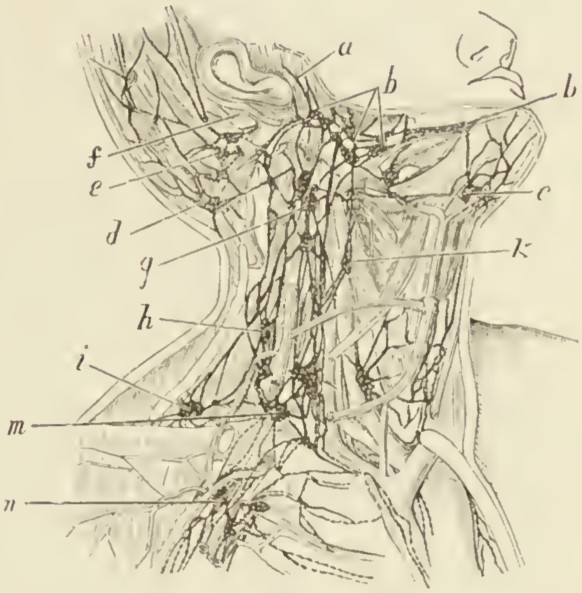


Fig. 102.—Lymphatic Glands of Head and Neck.

Glands in front of and below the ear, *a*, *b*; under the jaw, *b'*; under the chin, *c*; behind the ear, *e*, *f*; at the back of the head, *d*; in the neck and above the collar-bone, *g*, *h*, *i*, *k*, *m*; on the chest, *n*. The dark lines are communicating lymphatic vessels.

The **superficial glands** are few in number and small; the deep ones are very numerous and larger. The former are placed along the course of the external jugular vein, at the root of the neck, and on the voice-box. The **deep glands** form a chain extending from the base of the skull to the root of the neck, along the course of the internal jugular vein, carotid arteries, side of pharynx, gullet, and wind-pipe.

Lymphatics of the Upper Limb.—The **superficial lymphatic vessels** of the hand and forearm run in the course of the superficial veins. At the bend of the elbow they arrange themselves into two groups. The inner and larger group passes to the glands above the internal condyle, and from thence up the arm along the course of the basilic vein; and the outer, smaller group takes the course of the cephalic vein. The former terminate in the lymphatics at the lower part of the armpit, the latter pass upwards between the great pectoral and deltoid to reach the upper part of the armpit. The **deep lymphatics** accompany the blood-vessels to the armpit.

Glands.—The only important glands are a small group of two or three, above the inner condyle of the humerus, and

those in the armpit. The latter, called **axillary glands,** form two chains. One of these, running along the anterior fold of the armpit, receives the lymphatic vessels from the breast and front of the chest wall; it is these glands which become

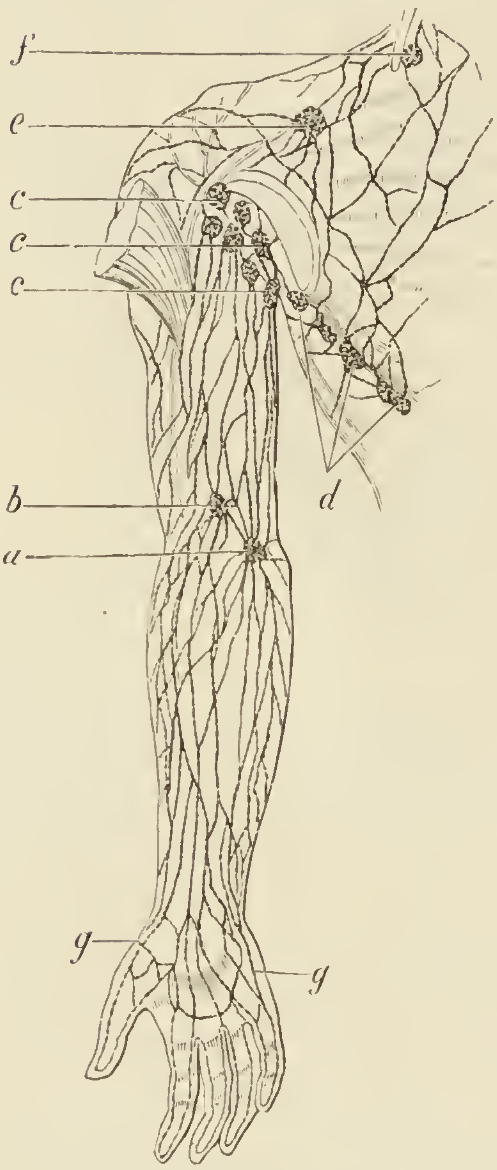


Fig. 103.—Lymphatics of the Arm and Armpit.

Glands at the inner side of the elbow *a*, *b*; in the armpit *c*, *c*, *c*; on the chest in front of the armpit *d*; above the collar-bone and communicating with the armpit *e*, *f*. *g*, *g* point to lymphatic vessels forming an arch round the hand. The dark lines are lymphatic vessels.

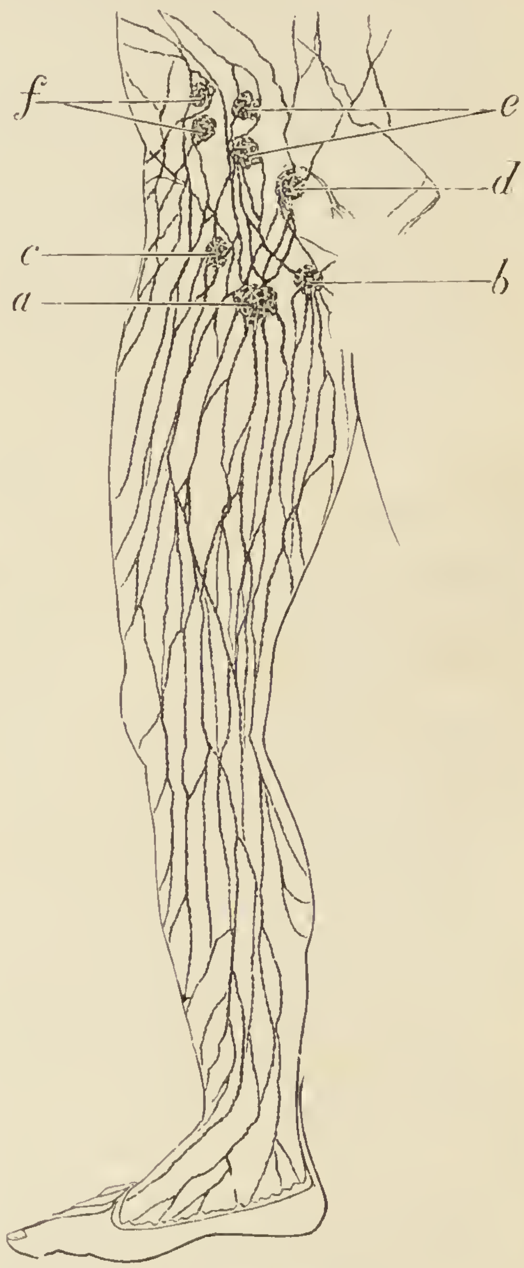


Fig. 104.—Lymphatic Vessels of Leg and Groin, and Glands of the Groin.

Inguinal glands, *d*, *e*, *f*; femoral glands, *a*, *b*, *c*. The dark lines are the lymphatic vessels.

enlarged in cancer of the female breast. The other chain is found occupying the back part of the armpit, and receives the lymphatic vessels of the back and scapular region.

Lymphatics of the Lower Limb.—The **superficial lym-**

phatic vessels follow the course of the external and internal saphena veins, and are consequently arranged in two sets, one passing up the back of the leg to the popliteal space, and the other along the inner side to the groin. **Deep lymphatic vessels** accompany the arteries and deep veins. The chief **glands** are those situated in the groin; they are separable into two sets—one (**inguinal**), running parallel with Poupart's ligament and a little below it, receives the lymphatics from the

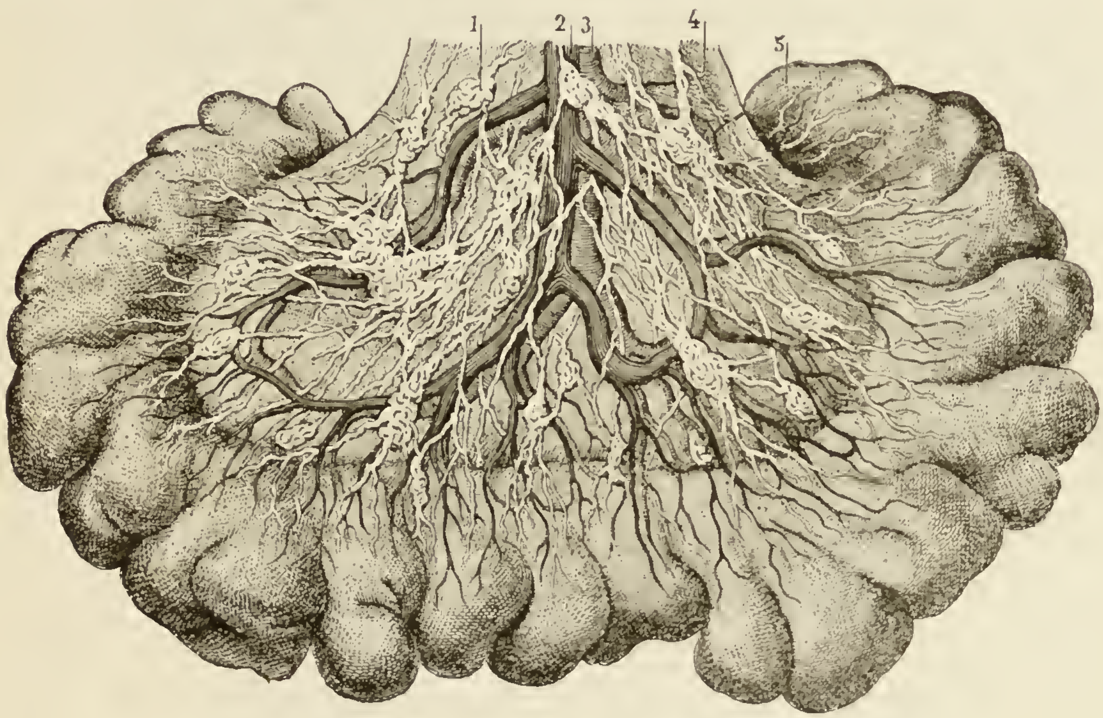


Fig. 105.—Mesenteric Glands.

4 points to the membrane of the mesentery, from which the bowel (5), seen in folds, is suspended. 1 points to a gland, a large number of which is present, connected to one another and to the bowel by fine lymphatic vessels. 2 indicates a vein, and 3 an artery ramifying through the mesentery and over the bowel.

abdominal wall and the genital organs; the other (**femoral**), placed vertically, and lying over the femoral artery, receives the lymphatics from the inner side of the foot and leg. A few glands are also found in the popliteal space, others deep among the muscles of the buttock, and one on the anterior interosseous membrane near the upper part of the tibia.

Lymphatics of the Trunk.—The **lymphatics of the abdominal viscera** are very numerous, and their arrangement is complicated. Those of the small intestine are the **lacteals.** They lie between the folds of peritoneum called the mesentery, and form an elaborate and beautiful net-work, in the midst of

which numerous glands—the **mesenteric glands**—are placed. The lacteals commence in the villi of the small intestine, where they receive the chyle resulting from digestion, and after forming a net-work in the mesentery, and passing through the glands, form several large trunks, which, uniting, empty into a sacculated vessel, the **chyle reservoir**, forming the beginning of the thoracic duct.

Along the back wall of the abdominal cavity there is a large chain of glands on each side, the **lumbar glands**; they may be traced along the sides of the iliac vessels, the aorta and the inferior vena cava. They receive the lymphatics of the lower limbs, pelvis, testicles, liver, spleen, pancreas, kidneys, and stomach.

The **Lymphatics of the Lungs** form a complex system of vessels distributed over every part of their surface, and penetrating very freely into their interior along the course of the bronchial tubes. The **Glands** connected with these vessels are placed at the root of the lung and near the bifurcation of the wind-pipe, and are known as the **bronchial glands**; they generally become, in dwellers in towns, the seat of a considerable deposit of carbon, probably derived from the air breathed.

The **Thoracic Duct** is the great lymphatic vessel which collects the lymph, from the greater part of the body and the whole of the chyle, and carries it into the veins at the root of the neck. It commences by a pear-shaped dilatation, the **Chyle Reservoir**, situated on the front of the body of the second lumbar vertebra, and immediately below the diaphragm. From this origin the thoracic duct passes through the aortic opening of the diaphragm and along the front of the vertebral column. It crosses over to the left side of the column about the middle of the chest, and runs behind the arch of the aorta and upwards as high as the sixth cervical vertebra, when it turns down and terminates at the junction of the left subclavian and internal jugular veins. On the right side a small duct, the **right lymphatic duct**, gathers up the lymphatics of the right arm, right side of head and neck, and part of the thorax, and empties into the veins of that side.

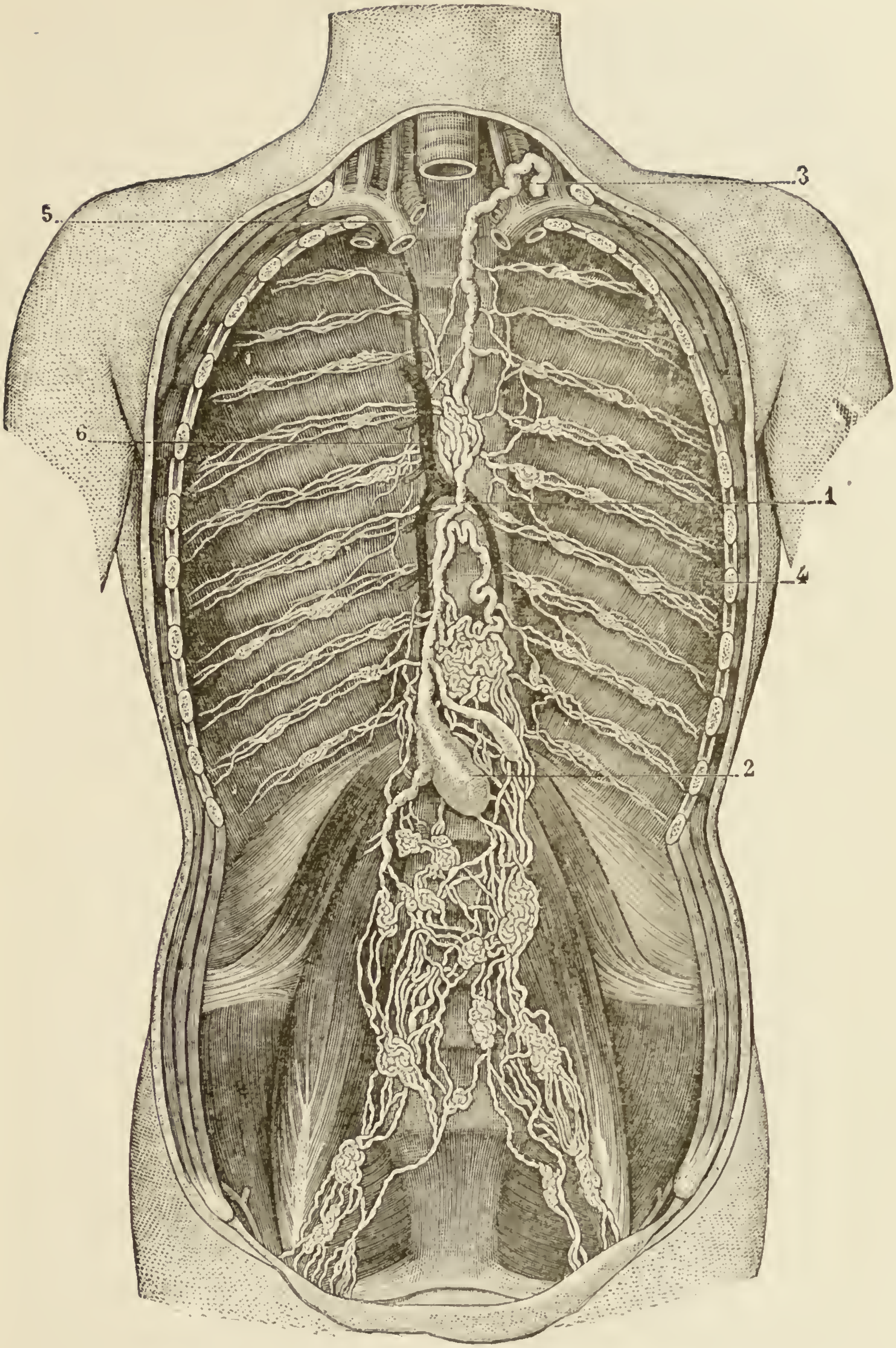


Fig. 106.—The Thoracic Duct and Lymphatic Vessels.

1, Thoracic duct; 2, chyle reservoir; 3, termination of the thoracic duct in the veins at the root of the neck; 4, intercostal lymphatics; 5, right innominate vein; 6, great azygos vein; 7, lumbar lymphatics and glands.

NEUROLOGY.

THE CENTRAL NERVOUS SYSTEM AND THE NERVES.

The central nervous system in man and other mammals is formed by two sets of central nerve apparatus, the **cerebro-spinal system**, and the **sympathetic system.** The cerebro-spinal system consists of the brain, the spinal cord, and the nerves springing from them; the sympathetic system is made up of numerous minute ganglia, either scattered irregularly through the body or arranged in chain-like series, and of fine non-medullated nerves connecting them together, or passing out from them to organs and tissues.

The brain is situated in the skull, the spinal cord in the canal formed by the arches of the vertebræ, but they are inseparably connected at the foramen magnum, and nerve-fibres pass from one to the other both in an upward and downward course.

The Spinal Cord.—The spinal cord is contained in the canal formed by the rings of the vertebræ, and extends from the foramen magnum to the upper border of the body of the second lumbar vertebra. It is from fifteen to eighteen inches in length, and is about the thickness of the little finger, but is thicker in the lower part of the neck where the nerves for the arms are given off, and also near its termination where the nerves for the legs have their origin. It is enclosed in coverings or membranes (**meninges**), which serve to protect it and to convey vessels for its nourishment. The inner of these called the **pia mater** is in close contact with the cord, and gives off supporting processes to its interior; outside this is a delicate film-like membrane, the **arachnoid**; and between these a space filled with a small quantity of fluid, the **cerebro-spinal fluid.** In consequence of the existence of this fluid the cord is, as it were, suspended in a water-bed, and is guarded against shocks; the fluid also provides a means by which

alterations in the position and vascularity of the cord may take place. Outside the arachnoid is a much thicker and stronger membrane, the **dura mater**, forming a protection for the cord, and loosely connected with the bones. The cord is kept in position in the canal (1) by its connection with the medulla oblongata above; (2) by a fine thread passing from its lower end to the sacrum (**filum terminale**); (3) by the nerves passing off from it on each side, and (4) by delicate festooned ligaments, the **ligamenta denticulata**, passing from the pia mater to the arachnoid and dura mater. Between the outer covering—the dura mater—and the bone, there are very numerous veins and a quantity of fine fat.

Structure of the Spinal Cord.—A transverse section of the cord demonstrates that its internal structure consists of white and gray nerve matter, the former being on the exterior and the latter in the interior. In front and behind are two fissures cutting into the cord, and in the centre a small canal, the **central canal**, which runs through its entire

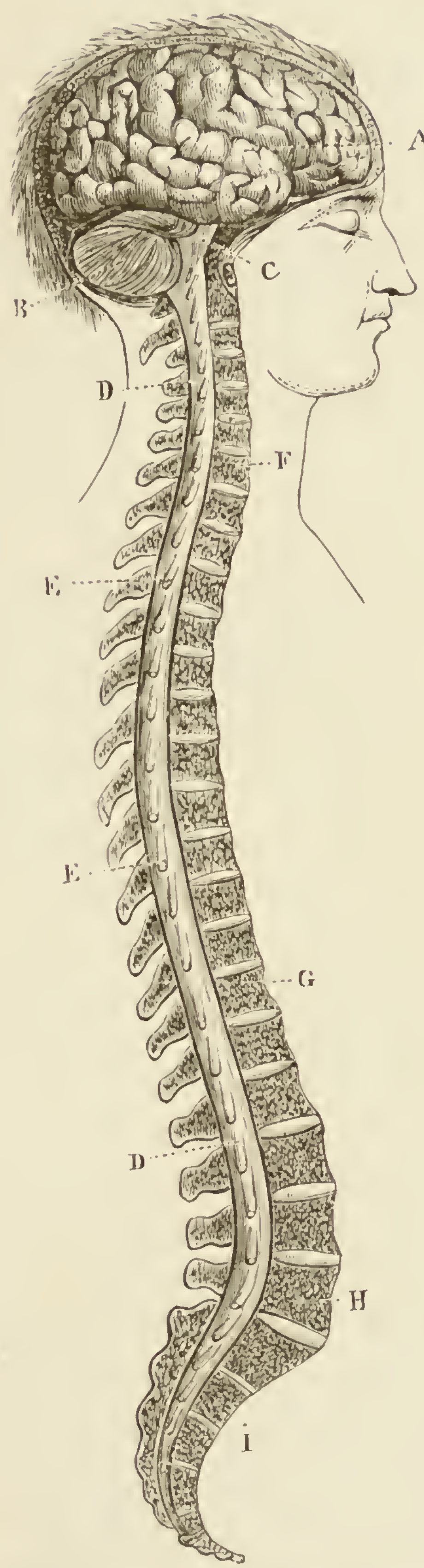


Fig. 107.—Brain and Spinal Cord in Position.

A, Cerebrum, or brain proper; B, cerebellum; C, pons Varolii, and below it the medulla oblongata; D, D, spinal marrow, showing the origin of the spinal nerves; E, E, spinous processes of the vertebræ: F, 7th cervical vertebra; G, 12th dorsal vertebra; H, 5th lumbar vertebra; I, sacrum.

length. The gray matter occupies the centre of the cord and forms two crescents placed back to back, and joined together by a **gray commissure**; one end of each crescent is large, irregular, and passes towards the front of the cord, this is the **anterior cornu** (horn). The other passes backwards, is thinner, sharper, and reaches nearly to the edge of the white matter, it is the **posterior cornu.** The white matter is divided into columns by the nerves passing from the cornua and by the fissures. In front, the white matter on each side of the anterior median fissure (and between it and the anterior horn) is called the

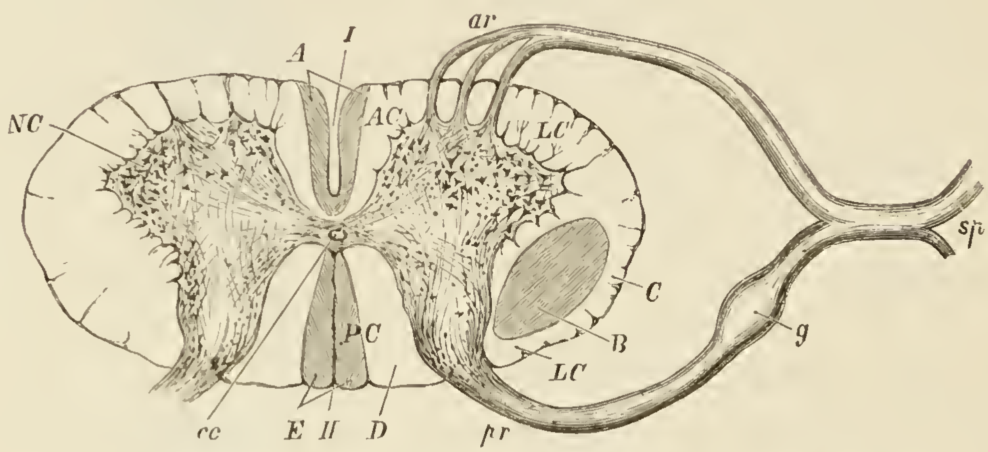


Fig. 108.—Cross Section of the Spinal Cord. Partly diagrammatic. Magnified.

I, Anterior median fissure; *II*, posterior median fissure; *A*, direct pyramidal tract; *A C*, anterior column; *P C*, posterior column; *L C*, lateral column; *C*, part of lateral column and *D*, part of posterior column going to cerebellum; *E*, Posterior median column; *B*, crossed pyramidal tract; *N C*, groups of cells in anterior horn; *c c*, central canal; *a r*, anterior root of spinal nerve; *p r*, posterior root; *g*, ganglion on posterior root; *s p*, spinal nerve.

anterior column; that between the posterior cornu and the posterior fissure, the **posterior column**; that between the roots of the spinal nerves, the **lateral column.** Besides these anatomical divisions there are also physiological ones, arising from what is known of the course and function of the several nerve strands passing to or from the brain. Thus in fig. 108 the part marked A passes to the hemisphere of the brain *on the same side* through the anterior pyramid of the medulla, hence it is named the **direct pyramidal tract.** B is a bundle of fibres which, passing through the pyramid of the medulla, goes to the *opposite* hemisphere of the brain, hence it is called the **crossed pyramidal tract.** C, part of the lateral column, and D, part of the posterior column, are strands going directly

to the cerebellum; the **direct cerebellar tract.** E goes to the cerebrum and is called the **posterior median column.**

The **gray matter** of the spinal cord consists of non-medullated nerve-fibres and of multipolar cells; the latter are especially large in the anterior cornu, where they are very much branched, and are connected with the origin of the motor nerves. The **white nerve matter** is formed by medullated nerve-fibres, some of which are the continuation of the spinal nerves, others connect the different parts of the spinal cord, and still others pass up to the brain.

Origin of the Spinal Nerves.—Each spinal nerve comes off from the cord by two roots connected with the two cornua of the central gray matter. The **anterior root** arises as scattered fibres, spread a little over the surface of the cord; it is smaller than the posterior trunk, is motor in function, and has no ganglion in its course. The **posterior root** is larger but more compact than the anterior; it is sensory in function, and has formed on it a ganglion of considerable size. The two nerves unite in a bony canal, the intervertebral canal, formed by the articulation of the vertebræ with each other; they again divide into two **divisions**, the **anterior** very large, and the **posterior** comparatively small. Both divisions are mixed nerves, that is, they are both motor and sensory. There are thirty-one spinal nerves on each side of the cord, and of these eight pairs come off in the neck (cervical), twelve in the back (dorsal), five in the loin (lumbar), five are sacral and one coccygeal. The upper pairs pass almost horizontally outwards, the lower ones slope much as they descend. The nerves which go to the legs come off very near each other, and pass down the canal in a bundle, called the **cauda equina** from the appearance of them resembling the tail of a horse. The distribution of the nerves will be described after the centres have been fully discussed.

THE BRAIN.

The encephalon or brain is contained in the cavity of the skull, enclosed in membranes like those enveloping the spinal cord. It is divided into the following parts, medulla oblongata, pons Varolii, crura cerebri, cerebrum or great brain, and cerebellum or lesser brain.

Medulla Oblongata.—The continuation of the spinal cord upwards to the brain is named the medulla oblongata; at its lower part it is undistinguishable from the cord, but as it ascends it widens out and becomes more complicated. In front the anterior median fissure of the cord is continued upwards; behind the posterior fissure is distinguishable at the lower part, but as it ascends it widens and forms a diamond-shaped cavity, the **fourth ventricle**. The upper part of the medulla is divisible into four strands on each side. (1) Next the middle line in front the **anterior pyramid**, the great motor tract; (2) outside this an oval projection, called from its appearance the **olivary body**; (3) further back a third strand, passing mainly to the cerebellum, the **restiform tract**; and (4) behind this a very narrow band, the **posterior pyramid**, continuous with the posterior median column of the cord, and passing up to the brain.

About the lower third of the medulla the anterior median fissure is interrupted by fibres crossing it, this communication being known as the **decussation of the pyramids**. In it the motor fibres of each lateral column of the spinal cord pass across to join those of the anterior pyramid of the opposite side.

The medulla oblongata is one of the most important parts of the cerebro-spinal system. It is traversed by all the nerve-fibres passing from the brain to the spinal cord; in its interior and on its posterior aspect are masses of gray matter from which several of the most important nerves arise. Some of these masses form the reflex centres for the movements of the heart, the movements of respiration, the movements of swallowing, the secretion of saliva, and the nerve influence on the blood-

vessels. Injury to the medulla is therefore always serious and often fatal.

Pons Varolii and Crura Cerebri.—Above the medulla oblongata is a transverse band of white nerve matter, known as the pons Varolii (bridge of Varolius). It is broad in the middle, and narrows at each side where its fibres pass into the cerebellum (little brain). It is formed mainly of nerve-fibres

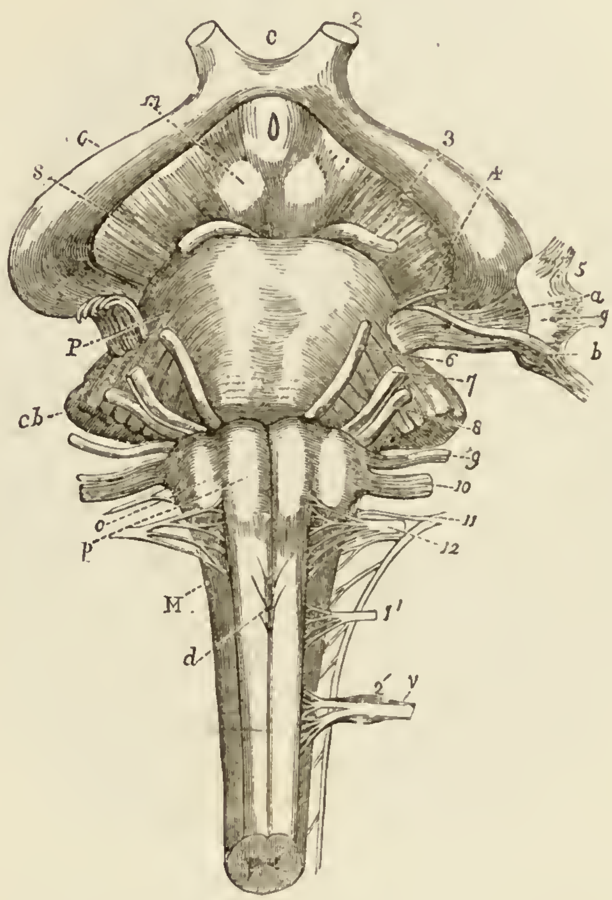


Fig. 109.—Medulla Oblongata and Pons Varolii.

M, Medulla oblongata; *p*, anterior pyramid; *d*, decussation of pyramids; o, olivary body; *P*, pons Varolii; *cb*, crus cerebelli; *s*, crus cerebri; *m*, corpus albicans; *t*, optic tract; *c*, optic commissure; 2, optic nerve; 3, third nerve; 4, fourth nerve; 5, fifth nerve; *a*, its sensory root; *b*, its motor root; *g*, Gasserian ganglion; 6, sixth nerve; 7, facial nerve; 8, nerve of hearing; 9, glosso-pharyngeal nerve; 10, vagus; 11, spinal accessory; 12, hypoglossal; 1′, first spinal nerve; 2′, second spinal nerve; *v*, its ganglion.

passing to, or leaving the cerebrum (great brain) and the cerebellum, but contains also a little gray nerve matter. The fibres may be divided into superficial and deep transverse fibres, connecting the two halves of the cerebellum; and superficial and deep longitudinal fibres passing from the medulla oblongata to the cerebrum. Emerging from its upper edge are two white strands, which diverge as they pass upwards to enter the under surface of each hemisphere; these are the **crura cerebri**, the foot-stalks or supporting stems of the brain. They contain the fibres continued from the medulla and passing to the brain.

Cerebrum or Great Brain.—The cerebrum or great brain is almost completely divided into two halves or **hemispheres** by a longitudinal fissure, and the surfaces of these are divided by tortuous grooves or sulci into **convolutions.**

The **Cerebrum** is oval in shape, arched above, and a little flattened below, narrower in front than behind, broadest about the level of the ears. The two **hemispheres** are held together by a broad arched band of white nerve matter, the **corpus callosum,** which can be seen at the bottom of the longitudinal fissure when the hemispheres are separated.

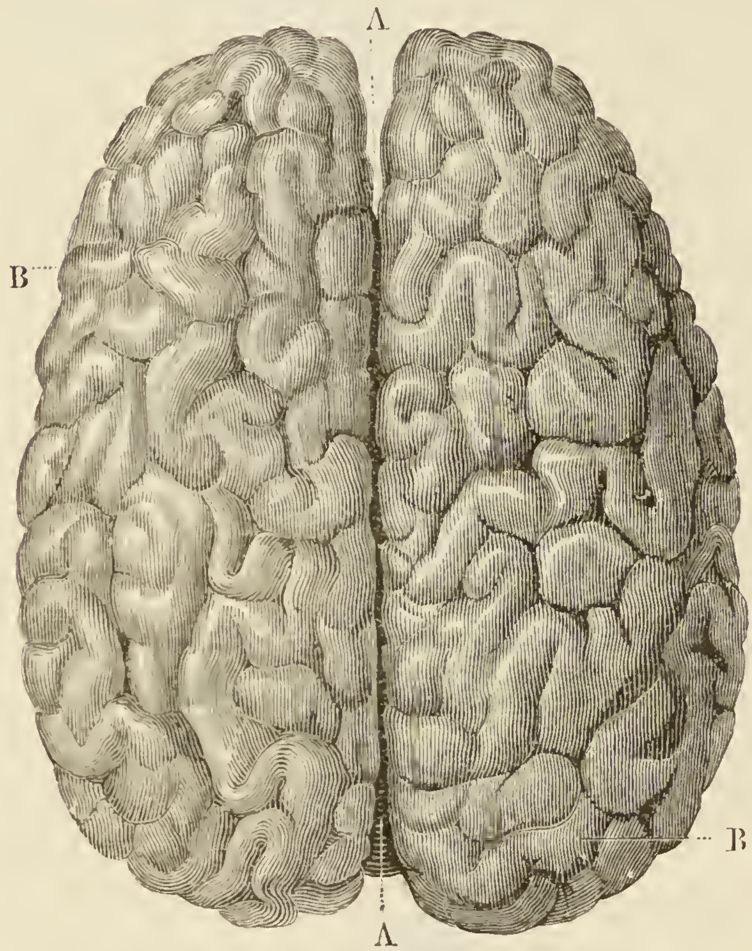


Fig. 110.—View of Upper Surface of the Brain.
A A, Great longitudinal fissure; B B, cerebral hemispheres.

Fissures. — The most important fissure on the side of the brain is the **fissure of Sylvius**; on the under aspect of the brain it divides the middle from the frontal part, and passes obliquely upwards on the outer surface for a considerable distance. Another important fissure may be seen on the convex upper and outer part of the brain, running obliquely downwards and forwards; it is called the **fissure of Rolando**, and has in recent years received great attention, because the convolutions bordering on it contain the motor centres for the leg, arm, face, and head. Still another fissure, called **parieto-occipital**, requires to be mentioned; it is situated near the back of the brain, and is well marked on the inner surface of the hemisphere, but extends only a short dis-

tance on to the vertex. Numerous other fissures are described and named, but they are not sufficiently important to justify their description in a work of this character.

Lobes and Convolutions of the Brain.—The anterior part of each hemisphere rests on the roof of the eye-socket, and forms the **Frontal lobe**; posteriorly, this lobe is limited by the fissure of Rolando and the fissure of Sylvius.

The **Parietal lobe** forms the middle part of the surface of the

Fig. 111.—Side View of Convolutions of Brain. [Wilson, after Marshall.]

C, Central lobe, or island of Reil: F, frontal lobe; P, parietal lobe; O, occipital lobe; T, temporo-sphenoidal lobe—the lower *c* indicates the anterior division of fissures of Sylvius, the upper *c* the precentral fissure; *d*, fissure of Rolando; *e*, Sylvian fissure, posterior division; *f*, parallel fissure; *g*, superior temporal fissure; 1, lower frontal convolution; 2, middle frontal convolution; 3, upper frontal convolution; 4, ascending frontal convolution; 4″, lobe of Broca; 5, ascending parietal convolution; 5′, superior parietal convolution; 5″, supra-marginal convolution; A, inferior parietal convolution; 6, angular gyrus; 7, first temporo-sphenoidal convolution; 8, second temporo-sphenoidal convolution; 9, third temporo-sphenoidal convolution; 10, first occipital convolution; 11, second occipital convolution; 12, third occipital convolution; α, First or upper external bridging convolution; β, second external bridging convolution; γ, third external bridging convolution; δ, fourth external bridging convolution.

hemisphere, and is bounded in front by the fissure of Rolando, below by the fissure of Sylvius. The posterior limit of this lobe is ill-defined in the human brain, in consequence of a number of **bridging convolutions** obliterating the parieto-occipital fissure.

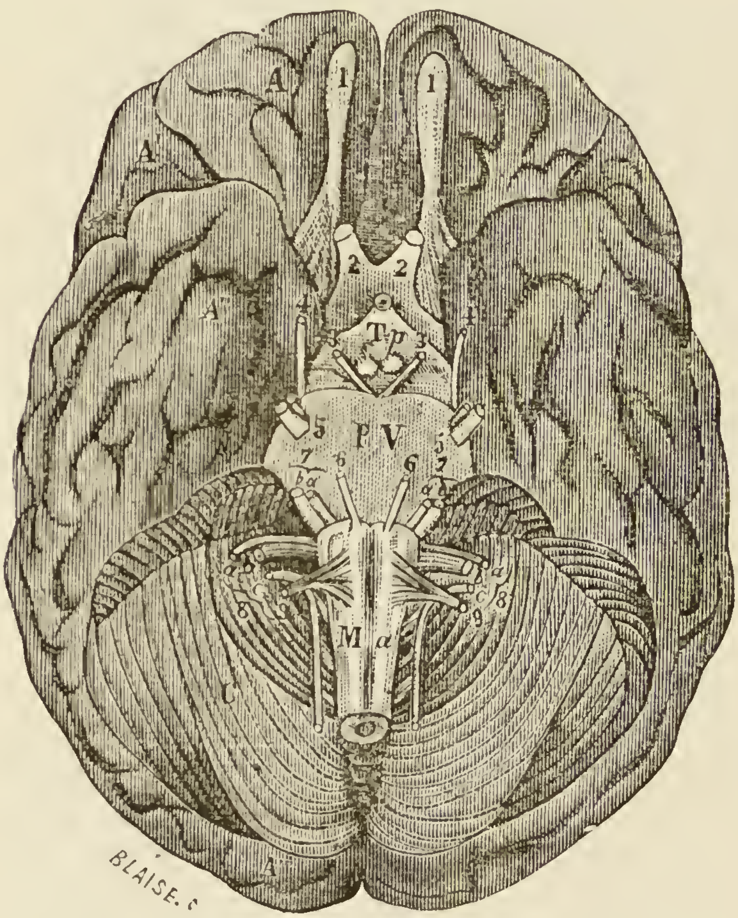
The **Occipital lobe** is the small posterior triangular portion of the brain, behind the parieto-occipital fissure.

The **Temporo-sphenoidal lobe** is the part of the brain lying on the temporal bone and great wing of the sphenoid: it is

separated from the rest of the hemisphere above, in front, and to the inner side by the fissure of Sylvius, but below and behind is in structural connection with the occipital lobe.

Situated deeply in the fissure of Sylvius is a small group of convolutions, receiving the name of the **Island of Reil** or **Central lobe**.

Base of the Brain.—At the under surface of the base of the brain we find the cranial nerves, and certain other structures



A, Frontal lobe; A′, fissure of Sylvius; A″, temporo-sphenoidal lobe; A‴, occipital lobe; C, cerebellum or lesser brain; *Ma*, medulla oblongata; P V, pons Varolii; T *p*, pituitary body; 1-1, first pair of nerves, or *olfactory* nerves; 2-2, second pair, or *optic* nerves; 3-3, third pair, or *common motor nerves* to *muscles of eyeball*; 4-4, fourth pair, or *pathetic nerves* for one muscle of eyeball; 5-5, fifth pair, *trifacial* or *trigeminal*, giving sensibility to face, tongue, and teeth, and motion to muscles of mastication; 6-6, sixth pair, or *abducent* nerves, to external rectus muscle of eyeball; 7-7, seventh and eighth pairs; *a*, *facial*, giving power of motion to muscles of face, and *b*, *auditory*, or nerve of hearing; 8-8, ninth, tenth, and eleventh pairs; *a*, *glosso-pharyngeal*, supplying sensibility to tongue and back of throat, also partially motor; *b*, *pneumogastric*, supplying throat, heart, lungs, and stomach; and *c*, *spinal accessory*, giving motor power to certain muscles of neck; 9-9, twelfth pair, or *hypoglossal*, supplying power of motion to tongue and to several muscles in neck.

Fig. 112.—View of the Lower Surface of the Brain.

which require to be recognized. If the brain be placed with its base upwards we notice those structures in the following order, proceeding from before backwards:—(1) The **longitudinal fissure**, and at the bottom thereof the anterior extremity of the **corpus callosum**; (2) on each side of this fissure are seen the **olfactory bulbs** and **tracts** (nerves of smell) lying on the under surface of the frontal lobes; they constitute the first pair of cranial nerves; (3) behind the fissure the **optic nerves** (nerves of sight) are found; they are united in a firm and complex union

—the **optic commissure**—behind which they may be traced backwards as a white band on each side of the under surface of the brain, the **optic tracts**; (4) between the front parts of the optic tracts is a small funnel of gray matter (tuber cinerium) connected with a peculiar little mass, the **pituitary body**; and behind this (5) are two little white eminences (**corpora albicantia**); (6) further back we see the two foot-stalks of the brain (**crura cerebri**) emerging from the pons; (7) between the two crura are placed the **third nerves**, for the supply of the muscles of the eyeball. Next comes (8) the **pons Varolii** (already described), on the outer sides of which will be seen (9) the **fourth nerves**; emerging from its substance are (10) the **fifth nerves**, and in the groove between it and the medulla oblongata there spring the **sixth** (11) and **seventh** (12) cranial nerves. Behind the pons will be seen (13) the **medulla**, the parts of which have been already described. In addition, we see the under surface of the frontal and temporo-sphenoidal lobes and the lateral halves of the cerebellum.

Interior of the Brain.—The interior of the brain contains several cavities called **ventricles**, the remains of the vesicles from which it was originally formed. Two of these much larger than the rest are found in the interior of the hemispheres, and are called the **lateral ventricles**; it is these especially which become distended in what is popularly called "water on the head", or hydrocephalus. On their floor is a longitudinal band of white nerve matter, the **fornix** (fig. 113, K), and beneath it the **pia mater** (one of the membranes of the brain) penetrates into the interior, carrying arterial and venous plexuses. These structures separate the cavity of the lateral ventricles from a smaller space near the base of the brain, the **third ventricle**; this communicates by a small canal (the **aqueduct of Sylvius**) with a space, the **fourth ventricle**, placed between the pons and medulla below and the cerebellum above.

Embedded in the lower part of the hemispheres are what are known as the **basal ganglia**; they contain a very large amount of gray matter (nerve cells and non-medullated nerve fibres), and are connected with the nerve fibres of the crura,

pons, and medulla. There are two of these at each side, namely, in front a mass presenting a streaked appearance, in consequence of the gray matter being traversed by white fibres, the **corpus striatum**; and behind this a grayer mass, the **thalamus opticus**. The **corpus striatum** is concerned in the conveyance downwards of motor impulses to the muscles; injury or disease of it, therefore, produces motor paralysis. The **thalamus opticus** (fig. 113, C) receives the sensory nerves, and forwards

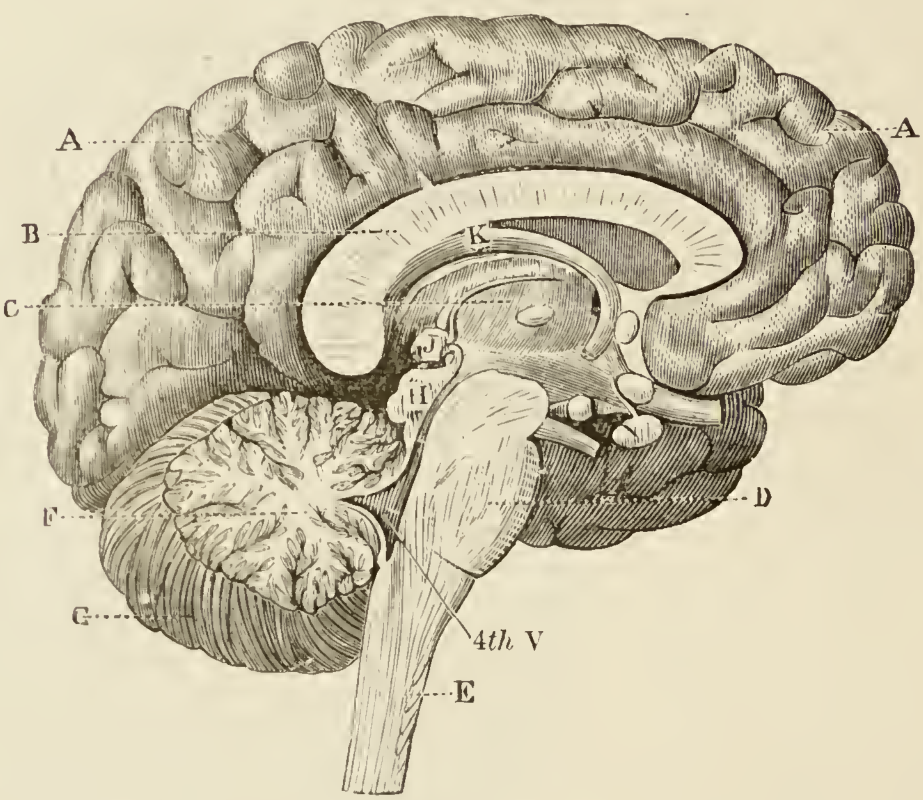


Fig. 113.—View of a Section of the Brain in the Median Line. The inner aspect of the left side is seen.

A, Plane of the longitudinal fissure; B, corpus callosum; C, optic thalamus; D, pons Varolii, under which is seen the medulla oblongata; E, spinal cord; F, section of cerebellum, showing its peculiar arborescent appearance, which has given it the name of "tree of life"; G, left half of the cerebellum, showing folia; H, corpora quadrigemina; J, pineal gland; K, fornix; *4th v*, fourth ventricle.

sensory impressions to the cortex of the brain; injury or disease of it, therefore, produces sensory paralysis. In both cases it is the opposite side of the body which is affected, this result being brought about in the case of the corpus striatum by the nerves crossing to the opposite side in the medulla (**decussation of the pyramids**), and in the case of the optic thalamus by the nerves crossing in the spinal cord.

Near the middle line, overlying the upper part of the pons,

are twin-like bodies, having the appearance of each being divided into two to form four, the **corpora quadrigemina** or **optic lobes** (fig. 113, H). They are white on their exterior, but contain gray matter in their interior, and are connected with the sense of vision and the movements of the eyeballs.

The different parts of the brain are connected together by fibres passing in various directions; of these the most important are (1) the transverse fibres of the **corpus callosum**, (2) those crossing the cavity of the third ventricle, and (3) the **longitudinal fibres of the fornix.**

The great brain differs from the spinal cord in having its white matter in the interior and the bulk of its gray matter on the surface. The latter forms a layer of about three-quarters of an inch in thickness, spread over the surface of all the convolutions, and dipping into all the fissures; it is assumed that in this gray matter mental processes have birth, motor acts originate, and sensations are experienced. Gray matter is also found in other parts of the cerebrum, such as the basal ganglia, the base of the brain, corpora quadrigemina, crura, pons Varolii, medulla, &c.

The Cerebellum.—The **cerebellum** (fig. 113, G), or lesser brain, lies in the posterior fossa of the cranium, and in man is covered by the posterior lobe of the cerebrum. It is placed behind and above the pons and medulla, and is connected with the latter by the restiform tracts. It consists of two hemispheres, joined together by a central mass, called the **vermiform process**, and has on its under surface a depression or **valley** which receives the medulla oblongata. It is separated from the cerebrum by a horizontal shelf, formed by the dura mater of the brain, and called (from its appearance) the **tentorium cerebelli.** The cerebellum is connected with other parts of the nerve centres by a strand of white matter on each side, the **crus cerebelli**, and each crus is found to consist of three tracts or peduncles—(1) one from the great brain (**processus e cerebello ad testes**); (2) another connecting the two hemispheres of the cerebellum (the **pons Varolii**); and (3) the third, the **restiform tract**, passing to the medulla.

The exterior of the cerebellum is divided into lobes, and these again into small divisions by horizontal furrows, so that, instead of forming convolutions like those of the great brain, it forms narrow sections, resembling the leaves of a book as seen from the edge. Its internal structure shows large strands of white matter radiating from the centre and dividing into numerous branches; around these branches the gray matter is arranged in such a manner as to suggest the leaves of a tree, and hence the appearance has received the name of **arbor vitæ** or **tree of life.**

Membranes of the Brain.—The brain is protected by the same three membranes as the spinal cord, but they are somewhat differently arranged. The inner membrane, the **pia mater**, covers the whole of the convolutions, dips into all the fissures, and penetrates into the interior of the brain at the back part; it is crowded with blood-vessels passing to the brain surface, and its connection with the latter is maintained chiefly by the small vascular twigs passing to it. It is thus the great vascular membrane, and its purpose is to supply blood to the brain.

The middle membrane, the **arachnoid**, covers the convolutions, but does not dip into the fissures. At the back part of the brain, at the base, and above the corpus callosum, an interval is left between the arachnoid and pia mater, which is occupied by the **cerebro-spinal fluid.** This fluid, as we have stated elsewhere, surrounds the spinal cord, and the space around the cord is in free communication with the spaces about the brain, so that the fluid can pass from the brain to the spinal cord or *vice versa.* Further, the same fluid is contained in the ventricles of the brain, and those cavities are in communication with the subarachnoid spaces of the brain and spinal cord.

The outer membrane of the brain is the **dura mater**; it is much thicker and stronger than the others. It closely lines the interior of the bones of the skull, and acts as a periosteum to them; its layers divide to form the venous channels, already described under the name of sinuses of the brain. Processes or folds of the dura pass between the several divisions of the

brain and serve to support and separate them. Of these processes the most important are the falx cerebri and the tentorium cerebelli. The **falx cerebri** is a sickle-shaped fold of dura mater, passing vertically down between the two hemispheres of the great brain, and attached below and behind to the tentorium; in its upper border runs the superior longitudinal sinus, in its lower the inferior longitudinal sinus, and in its union with the tentorium the straight sinus. The **tentorium cerebelli** is a process of dura mater, projected inwards between the cerebrum and cerebellum from the transverse ridge on the occipital bone, and attached in front to the edge of the petrous bone; at its anterior border is a large opening for the passage of the medulla and pons. In its connection with the occipital bone it forms channels for the lateral sinuses.

Blood-Vessels of the Brain.—The **arteries** are placed at the base of the brain, the main vessels uniting to form the series of communications described on p. 117 under the name of the **circle of Willis.** Branches of these arteries run in the fissures between the convolutions, and are distributed to the cortex of the brain; others pass into the interior to supply the basal ganglia and walls of the ventricles. It is a peculiar feature of the vascularization of the brain that, while an elaborate system of communicating vessels exists at the base, there are exceedingly few anastomoses in the substance of the organ, nearly every branch being what is called an "end-artery". The **veins** are very large, do not accompany the arteries, and are most numerous at the vertex; they end in the venous channels called sinuses.

The branches both of the arteries and veins, which ramify in the substance of the brain, are very small, and are much more copiously supplied to the gray matter than to the white.

Weight of the Brain.—The average weight of the brain is 49 ounces in the male and 45 ounces in the female. It attains its maximum weight at from 25 to 35 in the male and a little earlier in the female, remains stationary for about ten years, and then diminishes in weight at the rate of about 1 ounce for every ten years. The proportion which the weight

of the brain bears to the weight of the body is on an average 1 to 36·5.

CRANIAL NERVES.

The nerves derived from the brain are, for the most part, connected with the pons and medulla, but the first pair (olfactory) lie on the under surface of the frontal lobes; the second (optic) are in the middle of the base; and the third and fourth are placed in front and behind the crura cerebri. The following table shows the numbering and naming of the cranial nerves, according to the classification of Willis and of Soemmering; that of the latter author will be followed in this work:—

Willis.	Soemmering.	Name.
First.	First.	Olfactory.
Second.	Second.	Optic.
Third.	Third.	Motor of Eyeball.
Fourth.	Fourth.	Pathetic.
Fifth.	Fifth.	Trigeminal.
Sixth.	Sixth.	Abducent.
Seventh.	Seventh.	Facial.
	Eighth.	Auditory.
Eighth.	Ninth.	Glosso-pharyngeal.
	Tenth.	Vagus.
	Eleventh.	Spinal accessory.
Ninth.	Twelfth.	Hypoglossal.

First Pair of Cranial Nerves—Olfactory.—The **olfactory nerve** commences as the **olfactory tract** on the under surface of the frontal lobe of the brain; after running about an inch, it enlarges and forms an oval expansion, the **olfactory bulb**, which lies on the cribriform plate of the ethmoid bone. From the bulb a large number of very fine non-medullated nerve filaments pass through the sieve-like openings in the ethmoid, to the mucous membrane of the upper part of the nasal cavity. The part to which they go is known as the **olfactory tract**, and is the only part of the nose endowed with the sense of smell.

Second Pair of Cranial Nerves — Optic.— The **optic nerve** originates at the back part of the brain in connection with the thalamus opticus and corpora quadrigemina, and

forms a narrow flattened band, the **optic tract.** This winds rounds the under surface of the crus cerebri to reach the base of the brain, on the anterior part of which it joins with its fellow of the opposite side in the formation of the **optic commissure**, where an interchange takes place between the fibres of the two nerves. The optic nerves proceed from the commissure to the orbits, which they enter by the optic foramina in the sphenoid, to terminate in the back part of the eyeballs. As the name indicates, they are the nerves of sight.

Third Pair of Cranial Nerves — Motor Nerves of Eyeballs.—The **third nerve** emerges from the brain on the inner side of the crus cerebri, enters the orbit by the sphenoidal fissure, and is distributed to the levator palpebræ, superior rectus, inferior rectus, internal rectus, and inferior oblique muscles; that is to say, all the muscles of the eye-socket except the superior oblique and external rectus.

Fourth Pair of Cranial Nerves—Pathetic.—The **fourth nerve** comes from the outer side of the crus cerebri, enters the orbit through the sphenoidal fissure, and is distributed to the superior oblique muscle of the eye.

Fifth Pair of Cranial Nerves—Trigeminal.—This is one of the most complex and important of all the cranial nerves. It gives motor supply to all the muscles of mastication; gives sensation to the temple, face, surface of the eye, nasal cavities, and mouth; controls the secretion of the salivary glands; is connected with the sense of taste of the tip and sides of the tongue; and, finally, gives filaments to the teeth of both jaws. It arises from the lateral aspect of the pons in two nerve bundles; the smaller being motor in function, and the larger being sensory. After leaving the brain they lie near the tip of the petrous bone, and the sensory root spreads out to form a large ganglion, the **Gasserian ganglion**, from which three trunks are given off, the **ophthalmic**, the **superior maxillary**, the **inferior maxillary.**

The **Ophthalmic division** of the fifth nerve divides into three branches, which enter the orbit through the sphenoidal fissure; they are the frontal, lachrymal, and nasal. The **frontal**

nerve divides into branches which pass to the forehead, and are distributed to the skin; this nerve is one of the commonest seats of neuralgia (supra-orbital). The **lachrymal nerve** goes to the tear-gland, at the outer side of the orbit, and to the outer part of both eyelids. The **nasal nerve** goes to the interior and exterior of the nose, and to the eyeball and lower eyelid.

Fig. 114.—Branches of the Fifth Nerve.

Temporal fascia; 2, temporal muscle; 3, sensory branches to temple; 4 and 5, motor branches to temporal muscle; 6, external pterygoid muscle; 7, branch of masseteric nerve to temporal muscle; 8, nerve to buccinator; 9, masseteric nerve; 10, buccal branch of seventh; 11, nerve to temple and ear; 12, nerve to tongue; 13, facial nerve; 14, buccinator muscle; 15, internal pterygoid muscle; 16, branch of facial going to lower part of face; 17, inferior dental; 18, its mental branches; 19, its mylohyoid branch; 20, inferior dental canal; 21, masseter muscle. [Wilson, after Hirschfeld and Leveillè.]

The **Superior Maxillary division** of the fifth nerve leaves the skull through a small opening in the sphenoid bone (foramen rotundum), passes along a canal in the floor of the orbit, and comes out on to the face through the infra-orbital foramen just below the lower margin of the eye-socket. It supplies the muscles and skin of the face, and the teeth of the upper jaw; it is not infrequently the seat of neuralgia (infra-orbital).

The **Inferior Maxillary division** receives the motor root of the fifth, and therefore becomes a mixed nerve. It passes through the oval foramen in the sphenoid bone and divides into two trunks, one almost entirely sensory, and the other

almost entirely motor. The sensory trunk gives branches to the temple, parotid gland, teeth of the lower jaw, mucous membrane of the mouth and tongue; the latter branch (called **lingual**) is by some regarded as the nerve of taste of the front part of the tongue. The motor trunk supplies the muscles of mastication, namely, the temporal, masseter, external pterygoid, and internal pterygoid, and, in addition, part of the digastric muscle, and the mylo-hyoid which forms the floor of the mouth. A singular branch of the seventh nerve (the **chorda tympani**) enters into intimate relation with the lingual branch of the fifth.

Sixth Pair of Cranial Nerves—Abducent.—This is a small nerve springing from between the pons and medulla; it enters the orbit by the sphenoidal fissure and passes to the external rectus muscle of the eye. It also gives a branch to the eyeball.

Seventh Pair of Cranial Nerves—Facial.—The **seventh** is the great motor nerve of the face, supplying all the muscles of expression. It arises between the pons and medulla, and leaves the cavity of the skull by the internal auditory meatus in the petrous bone. It traverses a tortuous canal (the **aqueduct of Fallopius**) in the substance of that bone, and emerges a little to the inner side of the mastoid. In its course through the canal it runs along the upper part of the cavity of the middle ear (tympanum), and this explains how it happens that in some cases of suppurative disease of the ear, paralysis of the face ensues, the nerve being involved in the disease of the cavity. On reaching the exterior of the skull the facial nerve enters the substance of the parotid gland, and divides into a large number of branches which, as they leave the gland, spread out on the face and side of the head. The branches form numerous communications between themselves and with the branches of the three divisions of the fifth nerve, the mesh-like arrangement thus resulting having received the fantastic title of the **pes anserinus** or "**goose's foot**".

The facial nerve gives off, while in the petrous bone, a branch called the **chorda tympani**, which has proved a puzzle to anato-

mists and physiologists. It traverses the cavity of the middle ear, passing between the little bones situated there, and after leaving the temporal bone, enters the substance of the parotid gland; it there joins the lingual branch of the inferior maxillary, and with it passes to the submaxillary gland and to the tongue.

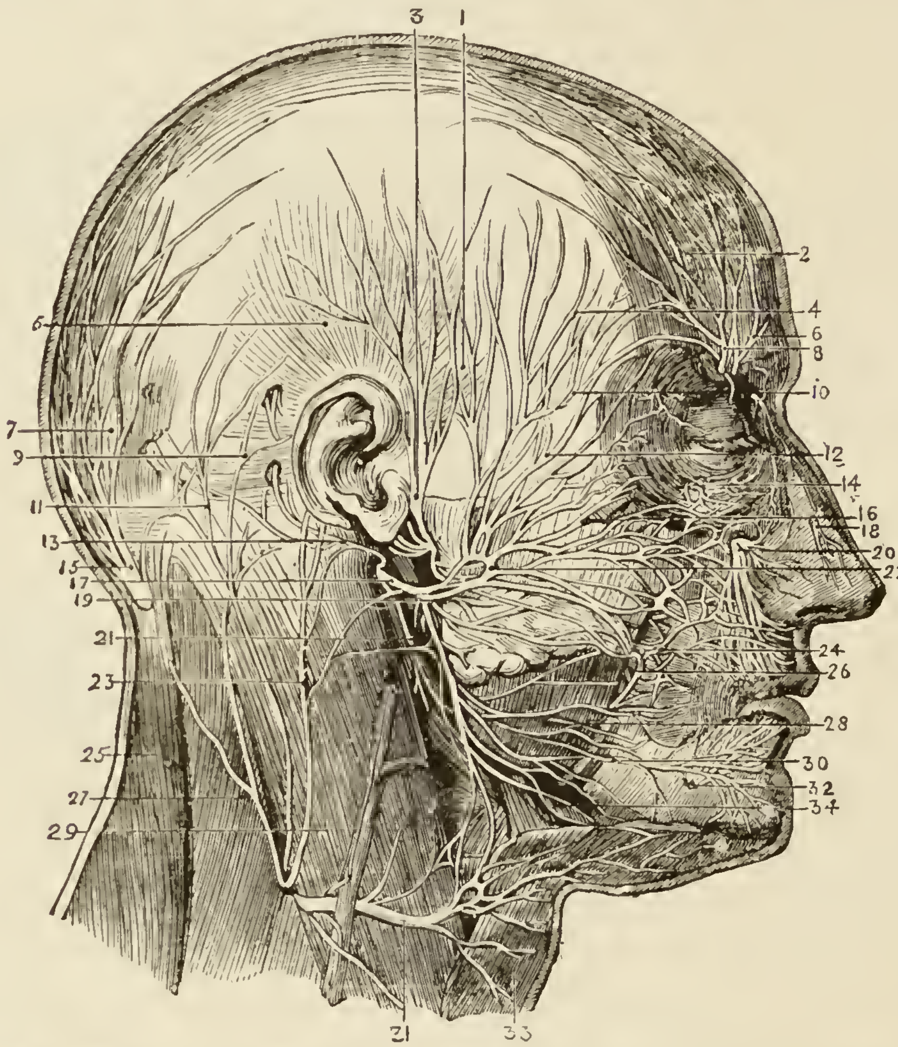


Fig. 115.—Nerves of the Face and Scalp. [Wilson, after Hirschfeld and Leveillè.]

1, Muscle of the ear; 2, occipital frontalis; 3, branch of fifth nerve to ear and temple; 4, temporal branches of facial; 5, elevator muscle of ear; 6, small branch of ophthalmic nerve; 7, occipito-frontalis (posterior belly); 8, supra-orbital branch of ophthalmic; 9, retractor muscle of ear; 10, small branch of superior maxillary nerve; 11, lesser occipital nerve; 12, malar branches of facial; 13, branch of facial to back of ear; 14, malar branches; 15, great occipital; 16, infra-orbital branches of facial; 17, facial; 18, nasal branch of ophthalmic; 19, cervico-facial division of facial; 20, infra-orbital branch of fifth; 21, branches of facial to digastric and stylo-hyoid; 22, temporo-facial division of facial; 23, great auricular; 24, buccal branches of facial; 25, trapezius muscle; 26, buccal nerve; 27, deep muscle of neck; 28, masseter; 29, sterno-mastoid; 30 and 34, branches of facial nerve; 31, superficial cervical nerve; 32, mental nerve; 33, platysma.

Some authorities regard this as the special nerve of taste of the front of the tongue.

The facial nerve gives branches to the muscles of the ear, to one belly of the digastric muscle, and to all the muscles of expression. Injuries to it cause facial palsy.

Eighth Pair of Cranial Nerves — Auditory. — The eighth nerve arises from the brain along with the seventh, and with it enters the internal auditory meatus in the petrous bone; at the bottom of that opening, however, the two nerves part company. The facial passes into the aqueduct of Fallopius, the auditory divides into two branches, the vestibular and cochlear, which go to the two main divisions of the internal ear. Their distribution will be considered when we come to speak of the organ of hearing.

Ninth Pair of Cranial Nerves.—The three next nerves —the glosso-pharyngeal, vagus, and spinal accessory—all arise from the medulla in the groove between the olivary body and restiform, and escape from the cavity of the skull through the jugular foramen; hence they were described by Willis as forming one pair, namely, the eighth. It is, however, more convenient to consider them separately.

The **Glosso-pharyngeal nerve**, after leaving the skull, passes forwards between the internal carotid artery and internal jugular vein, and winds round to the tongue, to the base and upper surface of which it is distributed. In its course it gives branches to the middle ear, pharynx (food-bag), tonsil, and the muscles of the pharynx. It is the special nerve of taste of the back part of the tongue.

Tenth Pair of Cranial Nerves—Vagus.—The **Vagus** or **Pneumogastric nerve** is the longest and most complex of all the cranial nerves, and is one of the most important nerves in the whole body. It gives branches to the membranes of the brain, the middle ear, the pharynx, the voice-box (larynx), the heart and great arteries, the lungs, the gullet, the stomach and the intestines.

After leaving the skull by the jugular foramen, it passes down the neck in the same sheath as the carotid artery and internal jugular vein, lying between and behind them, and occupies this position in relation to them till they reach the root of the neck. The right then passes across the right subclavian artery, and entering the chest, goes to the back of the root of the right lung; the left in like manner crosses the sub-

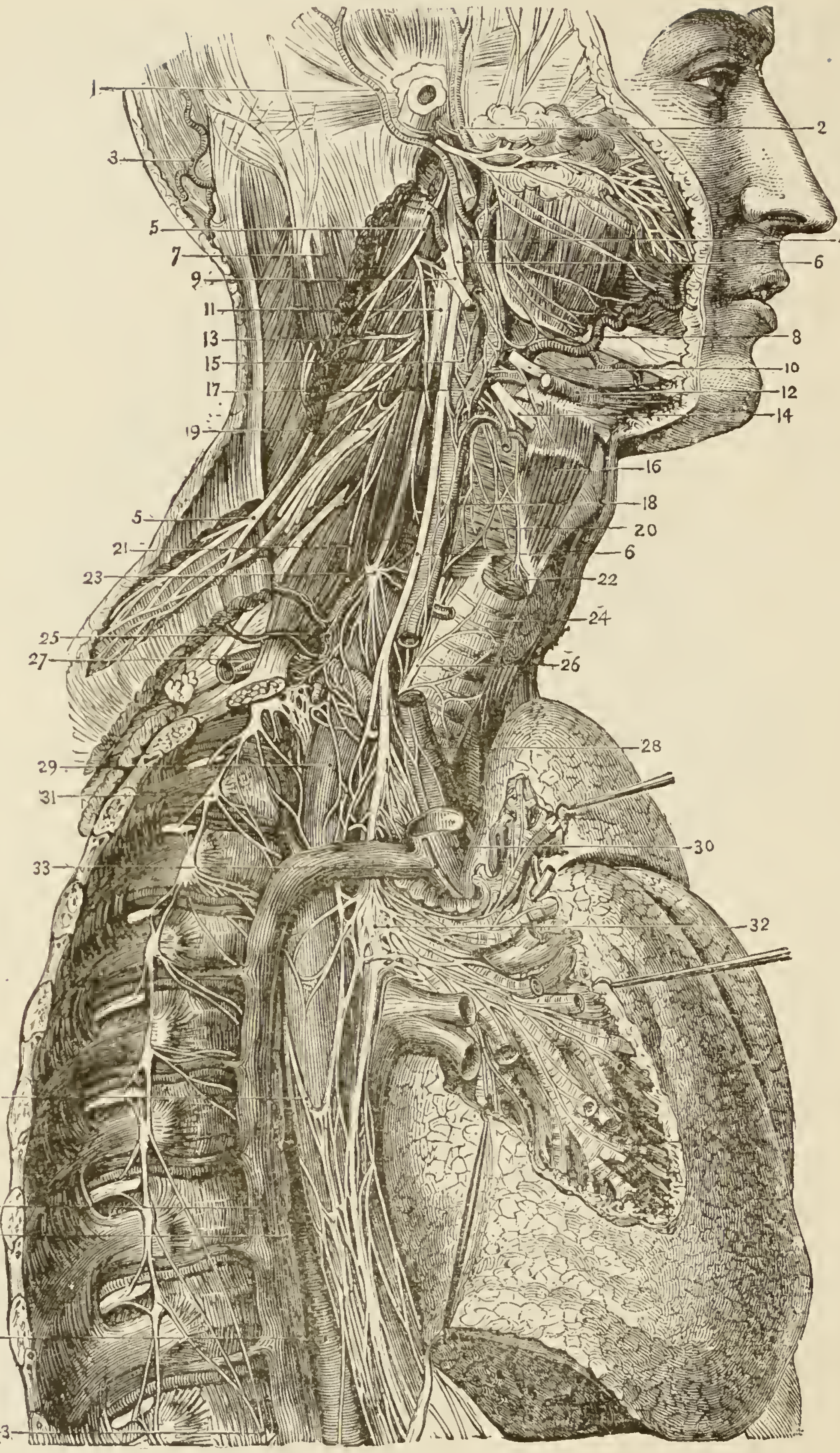


Fig. 116.—1, Posterior auricular artery; 2, temporal artery; 3, occipital artery; 4, glosso-pharyngeal nerve; 5, spinal accessory nerve; 6, vagus; 7, sterno-mastoid (cut); 8, facial artery; 9, hypoglossal nerve; 10, lower end of hypoglossal; 11, superior cervical ganglion; 12, digastric; 13, third cervical nerve; 14, superior laryngeal nerve; 15, internal carotid; 16, thyro-hyoid; 17, external carotid; 18, common carotid; 19, fourth cervical nerve; 20, inferior constrictor; 21, phrenic nerve; 22, crico-thyroid; 23, middle cervical ganglion; 24, trachea; 25, thyroid axis; 26, recurrent laryngeal nerve; 27, subclavian artery; 28, innominate artery; 29, œsophagus; 30, superior vena cava; 31, sympathetic cord; 32, posterior nerve plexus on root of lung; 33, phrenic nerve (cut); 35, œsophageal plexus; 37, azygos vein; 39, thoracic duct; 41, thoracic aorta; 43, great splanchnic nerve. [Wilson, after Hirschfeld and Leveillè.]

clavian artery, but then passes in front of the arch of the aorta in order to reach the back of the corresponding lung. From the lungs the vagus nerves pass on to the gullet, and there form a plexus with branches of the sympathetic nerve, the left vagus going to the front and the right to the back of that tube. The nerves finally pass through the aortic opening of the diaphragm to end in the walls of the stomach and intestines. On the stomach the left nerve is in front and the right behind.

The branches given off by the vagus to the larynx are of especial importance. They are two in number, the **superior laryngeal**, and the **inferior** or **recurrent laryngeal**. The **superior** is almost entirely sensory, it enters the larynx between the hyoid bone and thyroid cartilage, and is distributed to the mucous membrane lining the interior. The exquisite sensitiveness of the voice-box is due to this nerve.

The **Inferior** or **Recurrent Laryngeal nerve** runs a curious course, and is differently arranged on the two sides of the body. On the right side the recurrent nerve is given off just as the vagus is about to enter the chest; it winds round the right subclavian artery, and passing behind it ascends between the gullet and windpipe to the voice-box. The left nerve is given off lower down in the chest; it winds round the arch of the aorta, and passing behind the transverse part of that vessel, ascends along the windpipe to reach the voice-box. These nerves are distributed to the muscles of the larynx and the inferior constrictor muscle of the pharynx; they are the means by which vocal sounds are produced.

In the distribution of the vagus to the heart, lungs, gullet, stomach, and intestines, the nerve filaments form numerous communications with twigs derived from the sympathetic system; and it is generally admitted that the latter are the stimulating nerves, while the vagus branches are the regulating or inhibitory nerves.

Eleventh Pair of Cranial Nerves—Spinal Accessory. —This is a nerve which acts mainly as an assistant to the vagus, most of its fibres going to reinforce that nerve. It consists of

two portions, a **spinal part** arising from the lateral aspect of the cervical portion of the spinal cord, and passing up through the foramen magnum to the skull, and an **accessory portion** connected with the medulla immediately below the vagus. The spinal portion is distributed to the sterno-mastoid and trapezius muscles, the accessory portion joins the vagus where the two nerves lie in the neck below the jugular foramen.

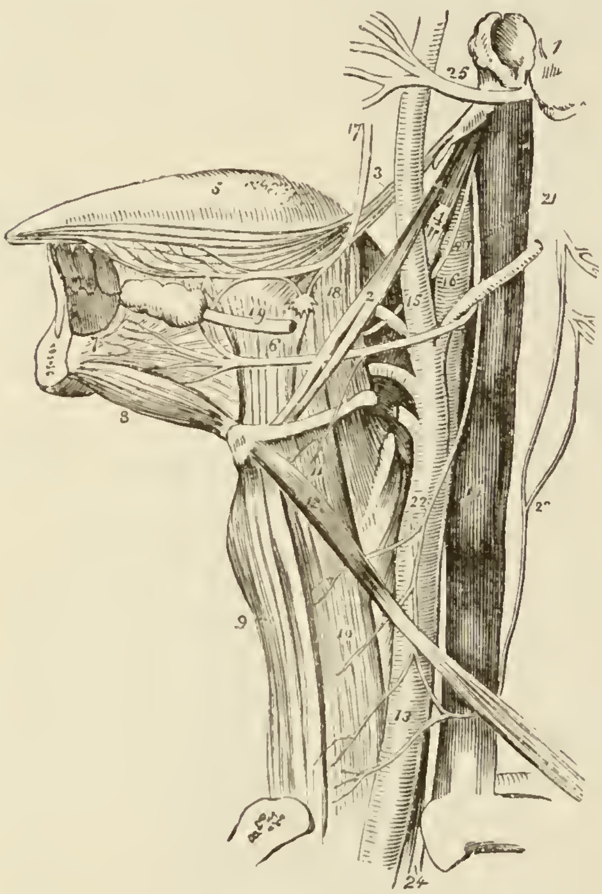


Fig. 117.—Nerves distributed to the Tongue and Side of the Neck.

1, Temporal bone; 2, stylo-hyoid muscle; 3, stylo-glossus; 4, stylo-pharyngeus; 5, tongue; 6, 18, hyo-glossus muscle; 7, genio-hyo-glossus; 8, genio-hyoid; 9, sterno-hyoid; 10, sterno-thyroid; 11, thyro-hyoid; 12, omo-hyoid; 13, common carotid artery; 14, internal jugular vein; 15, external carotid; 16, internal carotid; 17, lingual branch of fifth; 19, duct of submaxillary gland; 20, glosso-pharyngeal nerve; 21, hypoglossal; 22, descending cervical nerve; 23, communicating cervical nerve; 24, vagus; 25, facial nerve. [Wilson.]

Twelfth Pair of Cranial Nerves—Hypoglossal.—The **Hypoglossal nerve** springs from the medulla by two bundles of nerve fibres emerging from the groove between the anterior pyramid and olivary body. The nerve leaves the skull by a small opening in front of the occipital condyle, and passes forwards between the internal carotid artery and internal jugular vein; it then loops round the occipital artery close to its origin, crosses the external carotid artery, and is distributed to the muscles of the tongue, namely the hyo-glossus, genio-hyo-glossus, stylo-glossus, genio-hyoid, and thyro-hyoid.

As it curves forwards to these muscles it gives off a long branch to the neck, the **descending cervical nerve**. It passes down the neck in front of the sheath of the carotid artery, communicates with the cervical nerves, and gives branches to those muscles which depress the hyoid and voice-box, that is to say, the sterno-hyoid, sterno-thyroid, thyro-hyoid and omo-hyoid.

SPINAL NERVES.

There are thirty-one pairs of spinal nerves, each nerve arising from an anterior motor root and a posterior sensory root; their origin from the spinal cord has been described on p. 151. The roots unite in the intervertebral foramina, and the nerve so formed immediately splits again into two **divisions, anterior** and **posterior**, both of them being compound nerves. The anterior divisions supply the part of the body in front of the vertebral column, and are consequently much larger than the posterior, excepting in the case of the two upper cervical nerves, where the two divisions are about the same size.

The **spinal nerves** are as follows:—

Cervical,	8	pairs.
Dorsal,	12	,,
Lumbar,	5	,,
Sacral,	5	,,
Coccygeal,	1	,,

There are eight cervical nerves, because the first passes out between the occipital bone and atlas and the last between the seventh cervical and first dorsal. The dorsal, lumbar, and sacral nerves are the same in number as the vertebræ of those regions. The cervical nerves pass off transversely from the cord, the dorsal are oblique in direction, the lumbar and sacral almost vertical; the latter form the **cauda equina**.

Cervical Nerves.—The cervical nerves increase in size from the first to the fifth, and then remain the same size to the eighth. The anterior divisions of the four upper cervical nerves communicate with each other, and form the **anterior cervical plexus**. Those of the four lower cervical nerves and the first dorsal in like manner form the **brachial plexus**. The posterior divisions of the cervical nerves form a **posterior cervical plexus**.

Anterior Cervical Plexus.—The branches of this plexus are commonly divided into superficial and deep. The **superficial branches** spread out over the neck, and are distributed to the skin and superficial muscles; one runs on the sterno-mastoid

to the back of the ear and the parotid gland (**great auricular**), another to the back of the head (**lesser occipital**), and others run downwards across the clavicle and acromion to supply the skin over the chest as low down as the nipple line, and that over the shoulder.

The **deep branches** are chiefly distributed to the muscles of the neck. The most important of them, however, is not distributed in that region; it is the **phrenic nerve**. Coming off from the fifth and sixth cervical nerves it descends on the anterior scalene muscle, crosses the subclavian and internal mammary arteries to enter the chest; runs down between the pericardium and pleura, in front of the root of the lung to the diaphragm, which it supplies. It is, consequently, the great nerve of respiration, since it gives motion to the muscle chiefly concerned in the act of inspiration.

The **Posterior Cervical plexus** is distributed to the muscles and skin of the back of the neck. The largest branch derived from this plexus is the **great occipital**, a nerve distributed to the muscles and skin of the back of the head and neck.

Brachial Plexus.—As its name indicates this plexus contains the nerves distributed to the upper limb. It is formed by the anterior divisions of the four lower cervical nerves and the first dorsal. These, after branching and communicating with each other, at length form three strands, one placed to the outer side of the axillary artery, another to the inner side, and the third behind. These are known as the **outer, inner**, and **posterior cords** of the brachial plexus. The branches derived from these cords are here shown in tabular form:—

Outer Cord.	Inner Cord.
External Thoracic.	Internal Thoracic.
External Cutaneous.	Internal Cutaneous (2).
External Head of Median.	Inner Head of Median.
	Ulnar.

Posterior Cord.
Subscapular.
Circumflex.
Musculo-spiral.

Other branches are given off from the nerves before the plexus is formed; most of them are muscular branches, going to the muscles which connect the scapula with the neck. One of these (derived from the fifth and sixth cervical nerves) is called the **posterior thoracic**, or **external respiratory nerve of**

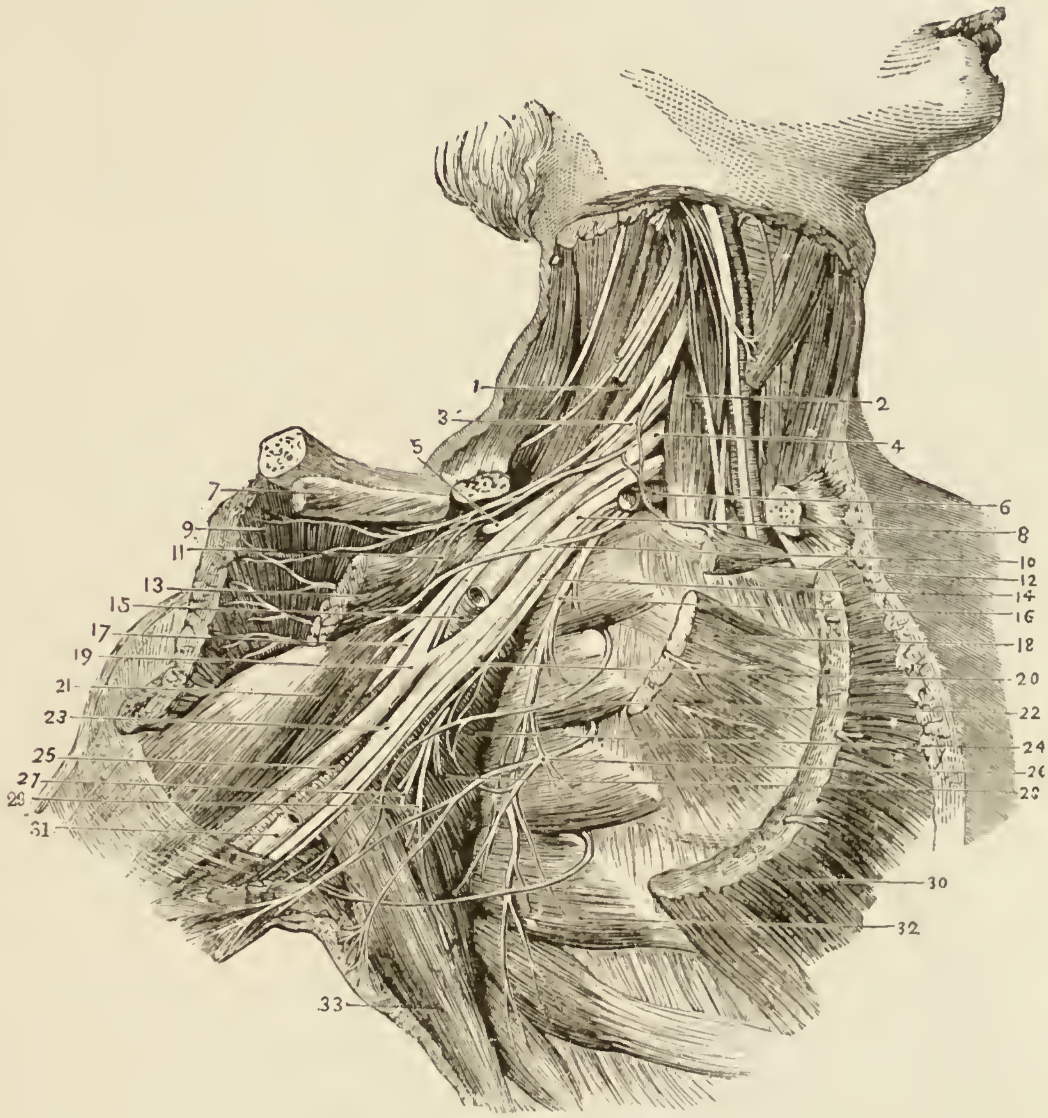


Fig. 118.—Brachial Plexus.

1, Middle scalene muscle; 2, anterior scalene; 3, cord formed by fifth and sixth cervical nerves; 4, seventh cervical nerve; 5, supra-scapular nerve; 6, subclavian artery (cut); 7, insertion of subclavius muscle; 8, cord formed by eighth cervical and first dorsal; 9 and 30, pectoralis major (cut); 10, internal anterior thoracic nerve; 11, external anterior thoracic; 12, origin of subclavius; 13, pectoralis minor (cut); 14, internal cutaneous nerve; 15, axillary artery (cut); 16, posterior thoracic nerve (Bell); 17, musculo-cutaneous nerve; 18, origin of pectoralis minor; 19, median nerve; 20, lesser internal cutaneous; 21, coraco-brachialis muscle; 22, intercosto-humeral nerve; 23, ulnar nerve; 24, subscapularis muscle; 25, brachial artery; 26, branch of third intercostal nerve; 27, 28, and 29, subscapular nerves; 31, basilic vein; 32, serratus magnus; 33, latissimus dorsi. [Wilson, after Hirschfeld and Leveillé.]

Bell. It passes down on the inner wall of the axillary space, lying on the serratus magnus muscle, to which it is distributed. It plays an important part in forced or full inspiration.

The **External Anterior Thoracic nerve** from the external cord and the **internal** from the inner cord are small branches going to the pectoralis major and minor.

The **External Cutaneous nerve** (called also **musculo-cutaneous**), after leaving the outer cord of the brachial plexus, pierces the coraco-brachialis muscle, and passes between the biceps and brachialis anticus to the outer side of the bend of the elbow. Here it divides into branches to be distributed to the front and back of the outer side of the forearm as far as the wrist. It gives motor filaments to the coraco-brachialis, biceps, and brachialis anticus muscles.

The **Median nerve** is one of the largest nerves in the upper limb. It is formed of two portions, one derived from the outer and the other from the inner cord of the brachial plexus. It lies at first to the outer side of the brachial artery, then—about the middle of the arm—crosses it, and at the bend of the elbow lies to its inner side. The nerve next passes deeply, beneath the muscles arising from the internal condyle, and runs down the middle of the forearm between the superficial and deep flexors of the fingers. Just above the wrist it is superficial, and is placed between the tendon of the radial carpal flexor and the outer tendon of the superficial flexor. It passes beneath the annular ligament to the hand, and there divides into its terminal branches.

Its distribution may be thus briefly stated:—**Muscles.**—It supplies all the muscles of the front of the forearm, excepting the ulnar carpal flexor, and half the deep flexor of the fingers. In the hand it supplies half the muscles of the thumb and the two outer lumbricales muscles. **Skin.**—It supplies the ball of the thumb and centre of palm of the hand; both sides of the front of the thumb, index finger, and middle finger, and the outer side of the ring finger. It communicates with the ulnar nerve.

While lying beneath the muscles attached to the internal condyle it gives off a branch, the **anterior interosseous**, which runs on the front of the interosseous membrane, and gives branches to the deep muscles.

The **Internal Cutaneous nerves**, two in number, are derived from the inner cord of the brachial plexus. They pass down the inner side of the arm, and supply the skin of the inner part of the arm, and the front and back of the inner border of the forearm. They do not supply any muscles.

The **Ulnar nerve** is also derived from the internal cord of the plexus. It runs down the inner side of the arm, to the back of the internal condyle, being accompanied in part of its course by the inferior profunda artery. At the back of the elbow it rests on the condyle, and when struck produces the tingling down the inner side of the little finger and palm of hand, familiarly described as "striking the funny bone". From this point it passes down the forearm, having in the lower two-thirds the ulnar artery as its associate. Reaching the wrist it enters the palm of the hand by crossing

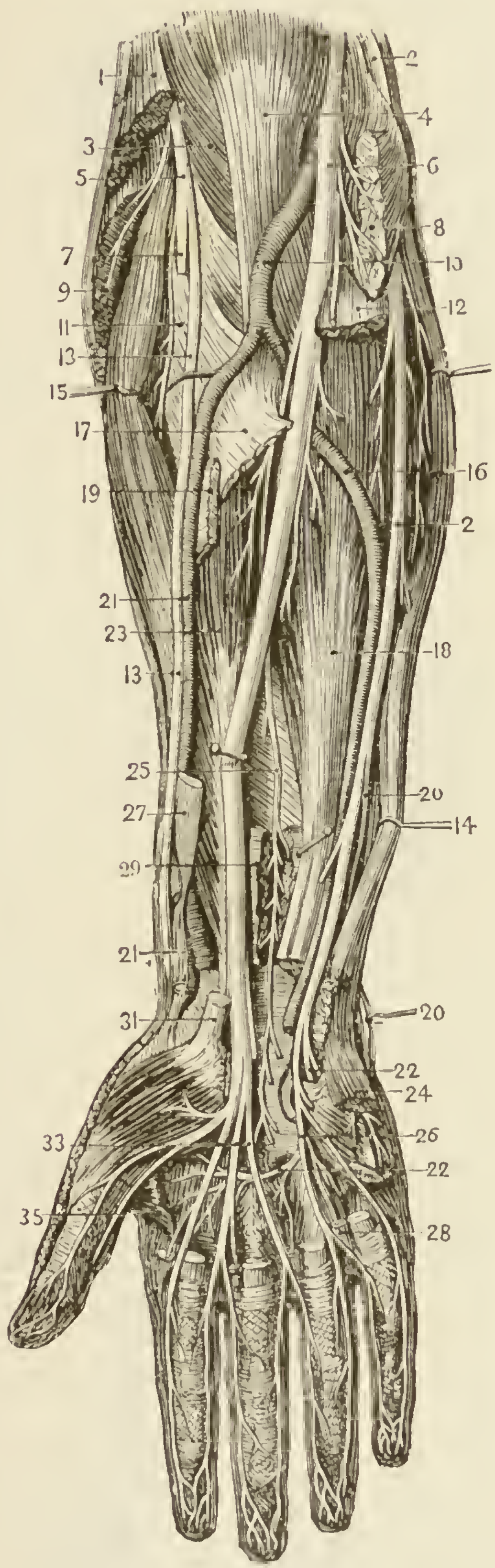


Fig. 119.—Nerves of the Front of the Forearm and Hand.

1, Long supinator (cut); 2, ulnar nerve; 3, brachialis anticus muscle; 4, biceps; 5, musculo - spiral nerve; 6, median nerve; 7, posterior interosseous nerve; 8, pronator teres and radial carpal flexor (cut); 9, long radial extensor of the carpus; 10, brachial artery; 11, short supinator; 12, superficial flexor muscle (cut); 13, radial nerve; 14, ulnar carpal flexor; 15, short radial extensor of the carpus; 16, ulnar artery; 17, radial origin of superficial flexor (cut); 18, deep flexor; 19, round pronator; 20, dorsal branch of ulnar nerve; 21, radial artery; 22, deep branch of ulnar nerve; 23, long flexor of the thumb; 24, abductor of little finger; 25, anterior interosseous nerve; 26, digital branches of ulnar nerve; 27, tendon of long supinator; 28, lumbricalis; 29, square pronator; 31, tendon of radial carpal flexor; 33, digital branches of median nerve; 35, adductor of thumb. [Wilson, after Hirschfeld and Leveillé.]

the annular ligament, and distributes branches to the fingers and to the muscles of the hand. A little above the wrist it gives off a cutaneous branch to the back of the hand. Its distribution may be summed up as follows:—**Muscles.**—Ulnar carpal flexor and half the deep flexor of the fingers, muscles of the little finger, two inner lumbricales, all the interosseous muscles of the hand, half the muscles of the thumb. **Skin.**—Part of the front of the forearm, inner side of the palm of the hand; in front, the little finger and half the ring finger; behind, the little and ring fingers and half the middle finger.

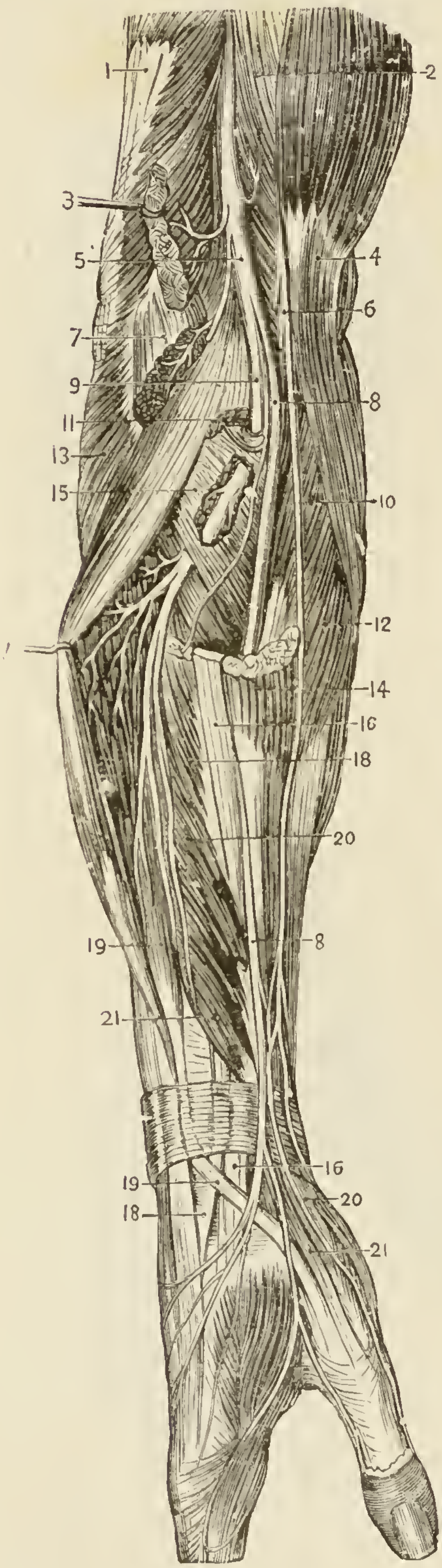


Fig. 120.—Nerves of Back of Forearm and Hand.

triceps; 2, brachialis anticus; 3, long supinator: 4, biceps: 5, musculo-spiral nerve; 6, musculo-cutaneous nerve; 7, origin of long radial extensor of carpus; 8, radial nerve; 9, posterior interosseous; 10, round pronator; 11, origin of short radial extensor of carpus; 12, radial carpal flexor; 13, anconeus; 14, tendon of long supinator; 15, short supinator; 16, tendon of long radial extensor of carpus; 17, common extensor; 18, tendon of short radial extensor of carpus; 19, 20, 21, tendons of extensors of thumb. [Wilson, after Hirschfeld and Leveillé.]

The **Subscapular nerves** are derived from the posterior cord of the brachial plexus. They pass to the subscapular, teres major, and latissimus dorsi muscles.

The **Circumflex nerve**, also derived from the posterior cord, is so named because it winds round the neck of the

humerus. It supplies the deltoid and teres minor muscles, and the skin over the deltoid.

The **Musculo-spiral** is a very large nerve, and is composed of nerve filaments derived from the four lower cervical nerves and the first dorsal. At its commencement it is placed behind the axillary and brachial arteries; it winds round the humerus between the triceps and the bone, along with the superior profunda artery, and reaching the outer side of the brachialis anticus, divides into two branches the **radial** and **posterior interosseous**. The **radial** is entirely a sensory nerve; it runs down the forearm in company of the artery of the same name, winds round to the back of the wrist with the artery, and is distributed to the back of the thumb, index finger, and half the middle finger. The **posterior interosseous nerve** passes to the back of the forearm to supply the muscles of that region.

The distribution of the musculo-spiral nerve may be summed up as follows:—**Muscles.**—Triceps, brachialis anticus, supinator longus, the two radial carpal extensors, all the muscles of the back of the forearm (both short and long). **Skin.**—The outer side of the upper arm, from the insertion of the deltoid downwards, the back of the forearm, and half the back of the hand.

Dorsal Nerves.—The twelve dorsal nerves are smaller than the lower cervical nerves. The posterior divisions pass to the skin and muscles of the back. The anterior divisions form the **intercostal nerves**, which run in the intercostal spaces, between the muscles, and supply them, as well as the skin covering the chest. The lower six intercostal nerves pass into the abdominal wall, and supply the muscles forming it and the skin covering it.

Lumbar Nerves.—There are five pairs of lumbar nerves. The posterior divisions pass to the muscles and skin of the small of the back. The anterior divisions lie at the back of the abdomen, between the muscles closing in that cavity behind; they form an intercommunication or plexus, the **lumbar plexus**.

The **branches** given off from the **lumbar plexus** are shown

in the following table, where the numbers give the nerves from which each branch originates:—

Ilio-hypogastric,	1.
Ilio-inguinal,	1.
Genito-crural,	1, 2.
External Cutaneous,	2, 3.
Anterior Crural,	2, 3, 4.
Obturator,	3, 4.
Lumbo-sacral,	4, 5.

The **Ilio-hypogastric** and **Ilio-inguinal** are nerves which pass to the lower part of the abdominal wall, but the former also gives a branch to the upper part of the buttock, and the latter to the inguinal canal.

The **Genito-crural**, as its name indicates, goes to the genital organs and the thigh. It supplies the cremaster muscle, and its cutaneous branch goes to the upper part of the thigh, a little below Poupart's ligament.

The **External Cutaneous nerve** passes beneath the outer part of Poupart's ligament, and is distributed to the skin of the front and outer side of the thigh, nearly as low down as the knee.

The **Anterior Crural nerve** is the largest of the branches of the lumbar plexus; it passes beneath Poupart's ligament to the thigh. It here lies to the outer side of the femoral artery, and at once breaks up into a number of branches, which are naturally divisible into **superficial branches** for the skin, and **deep branches** for the muscles. The former are called **middle cutaneous**, **internal cutaneous**, and **long saphenous**. The first two supply the skin of the front and inner side of the thigh as far as the knee; the third (**long saphenous**) runs down the inner side of the knee and leg to the inner ankle, and from thence is continued to the inner side of the foot and big toe. The **muscular branches** supply the sartorius, and the quadriceps extensor of the leg (rectus femoris, vastus externus, vastus internus, and crureus).

The distribution of the anterior crural nerve may be thus summed up:—**Skin.**—Front and inner side of thigh, inner side

of calf, ankle, foot, and big toe. **Muscles.**—Sartorius, rectus, vasti, crureus. It also gives branches to the hip and knee joints.

The **Obturator nerve** passes into the pelvis, and runs along the outer wall of that cavity to reach the obturator foramen, and through that opening reaches the thigh. It divides into branches which are distributed to the adductor muscles and skin on the inner side of the thigh.

Its distribution is as follows:—**Skin.**—Inner side of thigh assisting the internal cutaneous nerve. **Muscles.**—The adductor group, namely, adductor longus, brevis, and magnus, gracilis, pectineus, and the obturator externus. **Joints.**—Hip-joint and knee-joint. This distribution of the obturator nerve to both the knee and hip-joint explains the occurrence of knee pain in the early stages of hip-joint disease.

The **Lumbo-sacral nerve** consists of half the fourth lumbar nerve and the whole of the fifth (anterior divisions); it passes into the pelvis to join with the sacral nerves in the formation of the sacral plexus.

Sacral Nerves.—There are five sacral nerves; the first four escape through the sacral foramina, the last between the sacrum and coccyx. The **posterior divisions** are very small, and are distributed to the skin over the sacrum and the back part of the gluteal region. The **anterior divisions** diminish in size from above downwards. The first and second are of large size, the third is much smaller, and the fourth and fifth are exceedingly small.

Sacral Plexus.—The sacral plexus is formed by the union of the lumbo-sacral nerve and the anterior divisions of the three upper sacral nerves. It forms a large triangular mass lying on the back part of the outer wall of the pelvis. Its branches are as follows:—

Visceral.
Muscular.
Superior Gluteal.
Inferior Gluteal.
Pudic.
Lesser Ischiatic.
Greater Ischiatic.

The **Visceral branches** are distributed to the bladder and rectum in the male, and to the bladder, uterus, vagina, and rectum in the female.

The **Muscular branches** supply the external rotator muscles of the hip-joint.

The **Superior** and **Inferior Gluteal** are also muscular branches; the former supplies the lesser and least gluteal muscles, and the latter the great gluteal muscle. In order to reach these muscles the nerves pass through the great sciatic foramen.

The **Pudic nerve** accompanies the artery of the same name. It leaves the pelvis by the great sciatic foramen, crosses the spine of the ischium, re-enters the pelvis by the lesser sciatic foramen, and runs inside the ramus of the ischium to the perineum, where it supplies the external generative organs.

The **Lesser Ischiatic nerve** leaves the pelvis by the great sciatic foramen, and divides into the following branches:—(1) Branches to the great gluteal muscle, (2) one to the perineum (**long pudendal**), (3) one or more to the skin of the back of the thigh as far down as the popliteal space.

The **Great Ischiatic** (sciatic) nerve is a continuation of the greater part of the sacral plexus, and is by far the largest nerve in the body. As it leaves the great sciatic foramen to pass down the back of the thigh it measures fully three-quarters of an inch in breadth. It lies midway between the great trochanter of the femur and the tuberosity of the ischium, and descends to the upper part of the popliteal space, where it divides into two trunks, the **external** and **internal popliteal nerves**. In its course it gives motor branches to the hamstring muscles. The great ischiatic nerve is the seat of the pain in the affection known as sciatica.

The **Internal Popliteal nerve** is the larger of the two trunks, into which the great ischiatic nerve divides. Given off about three inches above the knee-joint, it runs through the popliteal space, lying nearer the surface than the popliteal artery, and separated from that vessel by the vein; a little below the knee it passes beneath the muscles of the calf, and changes its name

to **posterior tibial nerve**. The branches of this nerve are, the **muscular**, passing to the gastrocnemius, soleus, and plantaris; branches to the knee-joint, and the **external saphenous** nerve, which accompanies the vein of the same name to the back of the leg and outer side of the foot.

The **Posterior Tibial nerve**, the continuation of the foregoing, passes down the leg between the superficial and deep layers of muscles to the inner ankle, where it enters the sole of the foot, and divides into the **internal** and **external plantar nerves.** In its course it gives off branches to the deep muscles of the back of the leg, and a cutaneous branch to the skin of the heel and back part of the sole of the foot.

Fig. 121.—Nerves of the Back of the Thigh and Leg.

1, Gluteus maximus muscle; 2, gluteus medius; 3, gluteal nerve and artery; 4, gluteus minimus; 5, nerve to obturator internus; 6, pyriformis; 7, pudic nerve; 8, small sciatic nerve; 9, great sacro-sciatic ligament; 10, obturator internus and gemelli; 11, inferior gluteal nerve; 12, tendon of obturator externus; 13, inferior pudendal nerve; 14, quadratus femoris; 15, gracilis; 16, great sciatic nerve; 17, great adductor; 18, insertion of gluteus maximus; 19, origin of semi-tendinosus and biceps; 20, short head of biceps; 21, semi-membranosus; 22, tendon of biceps; 23, tendon of semi-tendinosus; 24, external popliteal nerve; 25, internal popliteal nerve; 26, communicating branch; 27, popliteal artery; 29, gastrocnemius; 31, cutaneous branch. [Wilson, after Hirschfeld and Leveillè.]

Of the two **plantar nerves** the **internal** is the larger, and

resembles in its distribution the median nerve in the hand. It runs along the inner border of the foot, and gives branches to the muscles passing to the big toe, and sensory filaments to the great toe, second, third, and half the fourth toe; and articular branches to the joints of the foot.

The **External Plantar nerve**, the smaller of the two, corresponds generally in its distribution with the ulnar nerve of the hand. It follows the course of the external plantar artery between the layers of muscles of the sole, and is distributed to the muscles of the little toe, and the deep muscles of the foot; it gives sensory branches to the skin of the little toe and the outer side of the fourth toe.

The **External Popliteal nerve**, smaller than the internal, runs along the inner border of the tendon of the biceps muscle, and near the head of the fibula divides into two branches, the **anterior tibial** and the **musculo-cutaneous**. In its course it gives off a branch to the skin of the outer and back part of the leg, one or more to the knee-joint, and a branch to join the external saphenous nerve.

The **Anterior Tibial nerve** runs on the anterior surface of the interosseous membrane, being covered by the muscles on the front of the leg, and giving branches to them. It crosses the ankle, and passes to the interspace between the great and second toes, where it ends by giving cutaneous filaments to the skin of the contiguous sides of those toes.

The **Musculo-Cutaneous nerve** winds round the outer side of the fibula to reach the front of the leg. It divides into two branches, which pass across the front of the ankle to the foot and are distributed to the contiguous sides of all the toes, excepting the big toe and second toe, which are supplied by the anterior tibial. It gives branches to the peroneal muscles and the skin of the lower part of the leg.

SYMPATHETIC NERVES.

The **Sympathetic** (fig. 116) forms a secondary system of nerves, connected with the cerebro-spinal nerves, but largely

independent of them. It closely resembles the ganglionic nervous system such as alone exists in insects, crustaceans, and many other invertebrates, and consists of very numerous ganglia (small nerve centres) connected by non-medullated nerve-fibres. On each side of the vertebral column the sympathetic forms a ganglionic chain, the number of ganglia in the dorsal, lumbar, and sacral regions corresponding with the number of the vertebræ; in the neck, however, there are only three ganglia, but the upper of these is very large, and is apparently formed by the fusion of several. Besides this chain there are scattered ganglia about the head, and in the cavities of the abdomen and pelvis; in the latter situations they are especially important, and give origin to very elaborate plexuses of fine nerves, distributed to the unstriped muscular fibres of the several organs, and to the muscular coat of the blood-vessels. There are also elaborate plexuses in the thorax in connection with the heart, lungs, and gullet; these are formed by an intermixture of sympathetic nerves with branches derived from the vagus nerve. The sympathetic filaments passing to the vessels are called **vaso-motor nerves**, because they cause contraction of the vessels; they regulate the supply of blood going to any part.

Very numerous communications take place between the sympathetic and cerebro-spinal nerves.

ORGANS OF SENSE.

The Organs of Sense are the means by which the person is brought into relation with surrounding objects; they are five in number (sometimes fancifully styled the five "Gateways of Knowledge")—the skin, the organ of touch; the nose, of smell; the eye, of sight; the tongue, of taste; and the ear, of hearing.

The Organ of Touch.—The **skin**, covering the whole surface of the body, is the organ of touch, but that is only one of the many uses to which it is put. Thus (1) it acts as a protective covering to the underlying structures; (2) it provides in the hair and nails, as well by its own texture and colour, a

means by which character and beauty may be given to the individual; (3) it supplies an important excreting apparatus for getting rid of nitrogenous products, water, and salts; (4) it is the chief means by which the temperature of the body is regulated; and (5) it is the organ of touch.

Structure of the Skin.—It is divisible into two layers, a superficial and a deep. The **superficial layer** is called the **Epidermis, Cuticle, or Scarf-skin**; it is demonstrated when a blister is applied to the skin, for fluid is thrown out between the two layers, and the cuticle is consequently raised up as a thin film. It is entirely composed of cells, the superficial layers of which are scale-like and hard (horny layer), and the deep ones round and soft (rete mucosum); the latter are in certain parts deeply pigmented. The epidermic cells fill up the inequalities in the upper surface of the derma or true skin; they are gradually pushed to the surface by the formation of new cells in the deep layer, and are thus constantly being detached as minute hard scales. As seen from the surface, the epidermis is intersected by a number of fine cross lines, and at the tips of the fingers and toes presents the appearance of concentric circles and wavy lines, which are different in each individual; so that it is possible to identify a person by the thumb or finger markings. On the surface, also, fine pores are seen, the openings of the sweat ducts, and numerous hairs project from the skin, especially in certain parts of the body.

Fig. 122.—The Structure of the Skin.

a, Horny layer; *b*, rete mucosum; *c*, corium or true skin; *c′*, masses of fat in the deep layer; *d*, subcutaneous tissue; *e*, sweat gland; *e′*, sweat duct; *f*, sebaceous follicle—a hair follicle is shown but not lettered.

The **True skin, Derma** or **Corium** is the deep layer of the skin. It is formed chiefly of fibrous tissue, the fibres of which are in the deeper layers loosely interwoven, so as to leave meshes, but in the superficial part they are closely united so as

to form a firm texture. The meshes of the deep part are occupied by pellets of fat, the hair bulbs, and the sweat glands; and the deep surface of the skin is covered by a thick layer of fatty tissue. The upper surface of the true skin forms a series of elevations, the **papillæ** (fig. 122, *b*). These are little finger-like projections, containing blood-vessels and nerves; they are completely enveloped in the cells of the epidermis, which also fill up the valleys between them. The true skin has a large number of blood-vessels, and the capillaries form loops in the papillæ. The nerves are also numerous, and terminate in special end-organs, some of which are distributed in the papillæ and others in the subcutaneous tissue. The commonest form are called **touch-bodies** or **tactile corpuscles**; they are placed in the papillæ, and are especially numerous in the skin of the fingers and toes, forearm, edges of the lips and eyelids. In the skin of the front of the finger they are very numerous, it being calculated that they average 50 to an area $\frac{1}{25}$ inch square. Another variety of nerve-ending is distributed in the subcutaneous tissue of the skin of the hand and foot. This form is known as the **Pacinian corpuscle**, and is arranged in the following way:—The nerve going to the skin divides into a number of fine branches, and these again give off minute twigs, on each of which there is a little semi-transparent grape-like body of a whitish colour; this is the Pacinian corpuscle. In vertical section, as shown in fig. 125, it is seen to consist of a central core (m) formed by the axis cylinder (n') of the nerve-fibre (n), ending in an

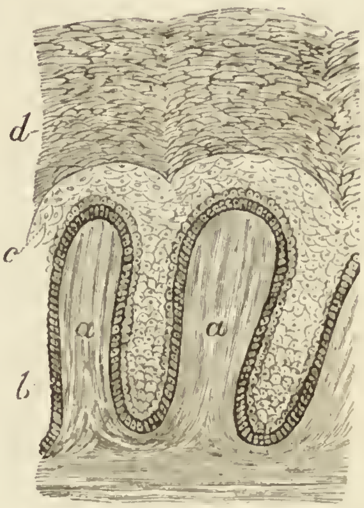


Fig. 123.—Vertical Section of Skin.

a, *a*, Papillæ; *b*, layer of cells covering papillæ; *c*, rete mucosum; *d*, horny layer of epidermis.

Fig. 124.—Magnified View of a Papilla of Skin, with a Touch Corpuscle.

irregular expansion (*a*). Outside this are numerous layers or capsules (*c*, *d*) formed of fibrous tissue and continuous with the nerve sheath. On entering the Pacinian body the nerve is medullated (*f*), but soon loses its medullary sheath, and only the axis cylinder passes into the core. The Pacinian bodies are most numerous in the neighbourhood of joints. A third form of nerve-ending is found in the papillæ of the red edge of the lips; it is called an **end-bulb**, and is formed of a small capsule enclosing a protoplasmic mass, in which the axis cylinder of the nerve ends.

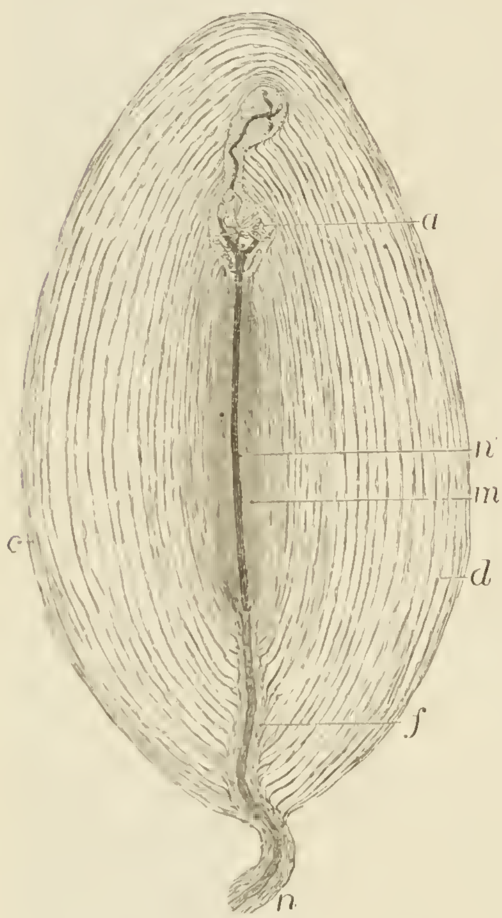


Fig. 125.—Pacinian Corpuscle.

a, Forked end of axis cylinder of nerve; *d*, capsule; *m*, fluid round axis cylinder; *n*, nerve entering; *n'*, axis cylinder.

The skin is continuous with mucous membrane at the orifices of the body, and the structure of the two is much alike, but the mucous membrane is thinner, more vascular, more elastic, and is devoid of hairs.

Glands of the Skin.—The special glands of the skin are the **sweat glands (sudoriparous glands)**. They consist of long convoluted tubes, placed in the deep part of the true skin, and of spiral ducts passing through the epidermis to reach the surface (fig. 122, *e* and *e'*). The tube is formed of a thin membrane lined by cubical cells; around the convoluted part of the tube there is a fine plexus of vessels, from which the material is derived for the formation of the sweat. Sweat glands are most numerous in the palm of the hand, where the openings number more than 3000 to the square inch, and next to that in the sole of the foot; they are fewest in the back and neck. The length of each tube averages $\frac{1}{4}$ inch, and the total number in the body has been estimated at about 3 millions; there are

thus very many miles of tubes in the glands taken collectively.

Hairs and **Nails** are structures connected with the skin, and are formed of modified epidermic cells.

Hairs.—Hairs are situated in depressions formed by the epidermis being pushed into the derma till it reaches the deep layer of that structure; the sac so formed is called the **hair follicle**. At the bottom of the follicle there is an upward projection of the true skin to form a **papilla**, which, like the other papillæ of the skin, contains blood-vessels and nerves. Around the papilla the hair commences as a globular expansion, the **hair bulb**, formed of cells like those of the rete mucosum of the skin. The cells on the surface of the papilla are actively growing, and are the means by which the hair grows; as the cells get pushed upwards by the new ones formed beneath them, they get compressed, and the shape of the follicle determines their aggregation into a cylindrical growth, the hair. So closely are they welded that, even under high microscopic powers, the hair only presents a fibrous appearance, excepting in the centre, where the cells are still large and distinct, forming the **medulla** or **pith**. The medulla of the hair contains the pigment giving it colour, but in old persons this is absent, the cells being occupied by air, causing the hair to be gray or white. On the surface of the hair, the scales forming it have an imbricated arrangement, like the tiles of a house, and in many animals (though not in man), the edges get broken up to form fantastic fringes. Opening into each hair follicle are one or more glands—the **sebaceous glands**—for the purpose

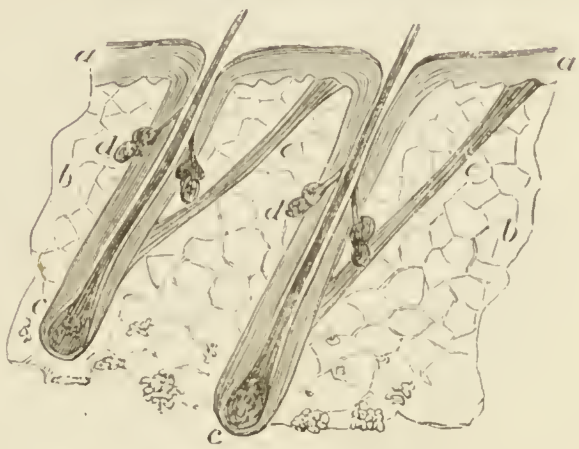


Fig. 126.—Hair, Hair Follicles and Glands. *a*, epidermis; *b*, true skin; *c*, hair bulb; *d*, sebaceous glands; *e*, muscle attached to hair sac.

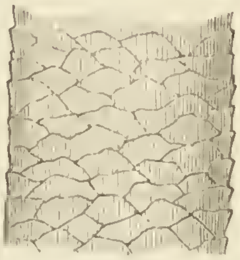


Fig. 127.—Outer surface of a Hair, showing the arrangement of the epithelial scales.

of lubricating the hair; they consist of a number of pouches lined by secreting cells.

In connection with each hair-sac is a bundle of smooth muscular fibres, for the purpose of erecting the hair (**erector pili** muscle); it is always placed on that aspect of the follicle towards which hair slopes, and passes from the follicle to the papillary layer of the skin. By its contraction this muscle causes the hair to become more erect or "stand on end".

A **Nail** is also formed of epidermic cells which have undergone compression, much in the same way as those forming the shaft of a hair. The nail lies upon very fine and closely-set papillæ, forming its **bed** or **matrix**, and is covered at its base by a fold of skin, from beneath which it seems to grow; this part of the nail is called its **root**.

The Organ of Taste.—The sense of taste is resident in the tongue and soft palate. The **tongue** is a muscular organ, covered on its upper surface by a thick layer of mucous membrane. The muscular fibre is of the striped or voluntary kind, but is notable for its free admixture with fine soft fat, the frequent branching of the fibres, and the close connection between the muscle and mucous membrane. The mucous membrane on the upper surface is thick and adherent, that on the under surface is thin and free; the latter forms a band connecting the tongue with the inside of the lower jaw in front and called the **frenum**, or bridle of the tongue. The back part of the upper surface of the tongue is covered by a mass of mucous glands (**lingual glands**), and the rest of that surface is covered by irregular projections, or **papillæ**. At the junction of the glandular with the papillated surface of the tongue is a peculiar group of structures called the **circumvallate papillæ**, arranged in the form of a very open **V**, with the point of the letter directed backwards. The circumvallate papillæ are commonly ten or twelve in number, an especially large one (foramen cæcum) being placed at the point of the **V**; each of them has the appearance of a circular ditch, with a tower-like papilla in the centre. The papillæ are freely supplied with blood-vessels and nerves, and are covered with many layers of

epithelium. At the sides of the central papilla, deep down in the ditch, are a number of flask-shaped bodies called **taste-**

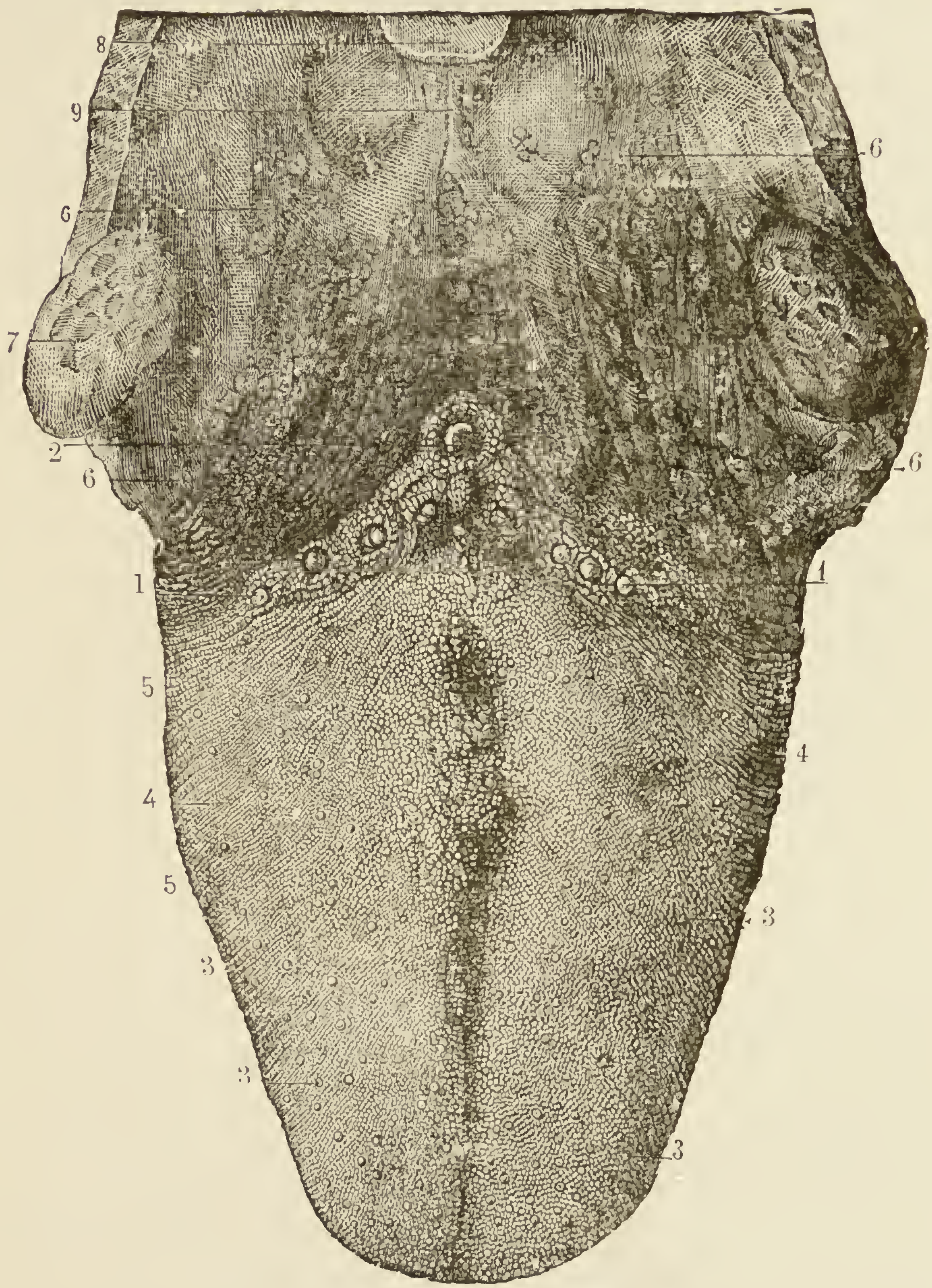


Fig. 128.—Tongue and Tonsils.

1, Circumvallate papillæ; 2, foramen cæcum; 3, fungiform papillæ; 4, filiform papillæ; 5, lateral rows of filiform papillæ; 6, glands at base of tongue; 7, tonsil; 8, epiglottis; 9, fold of mucous membrane between tongue and epiglottis. [Wilson.]

buds, the terminal organs connected with the filaments of the glosso-pharyngeal nerves. The taste-buds (fig. 129, T) are

collections of epithelial cells, the outer ones being shaped like barrel-staves, and the inner being thin, and pointed at the free ends. The mouths of the taste-buds open into the ditch, and the spike-like ends of the central cells project for a short distance through the openings; the deep ends of the cells are connected with the terminal filaments of the glosso-pharyngeal nerves. The ditch around each papilla seems to retain momentarily the substance to be tasted, and it is there

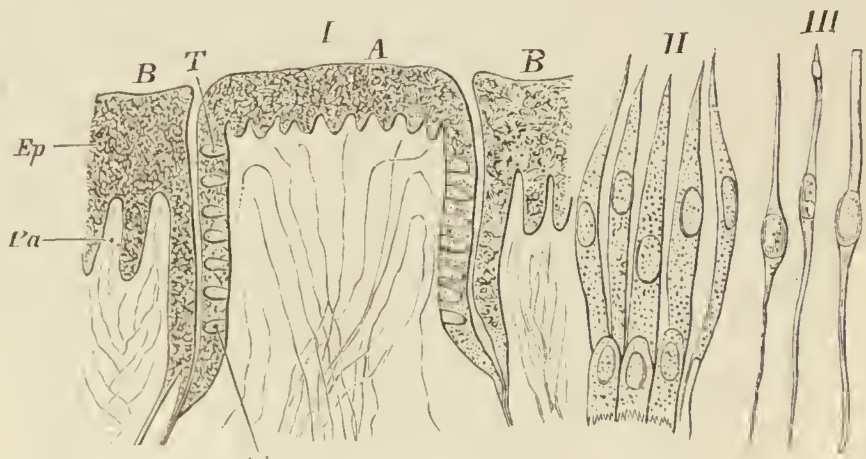


Fig. 129.—Section of Circumvallate Papillæ of the Tongue—highly magnified.

I *A*, Section of the central papilla; *BB*, section of the surrounding elevation; *Pa*, papilla of the true skin; *Ep*, layer of stratified squamous epithelium; *T*, taste buds; II and III represent very highly magnified views of cells of the taste-buds.

brought into contact with the cells of the taste-buds, and through them the influence is transmitted to the nerve-endings.

The anterior two-thirds of the upper surface of the tongue is covered by two other varieties of papillæ, the filiform and fungiform papillæ. The **filiform papillæ** are by far the most numerous, and are arranged in lines nearly parallel at the back with the line of circumvallate papillæ, and in front with the middle line; they are crowned by very fine brush-like processes formed of epithelial scales, and are mainly of use in breaking down the food in mastication. The **fungiform papillæ**, much less numerous, are scattered at irregular intervals over the surface of the tongue, and when that organ is covered with fur often appear as little red projections in the midst of the white. They are small mushroom-like projections, coated with a thick layer of epithelium, and connected at their base with the nerves of taste of the front of the tongue.

Nerves.—The nerves of taste are, at the back part of the tongue the glosso-pharyngeal nerves, in front the chorda-tympani nerves. The lingual branch of the fifth (sometimes called gustatory) confers on the tongue the sense of touch, pain, heat, and cold.

The Organ of Smell.—The **nose**, although properly regarded as the organ of smell, since odours have to pass through the nostrils to be apprehended, forms in reality only a small outlying part of that organ. The essential portion is the mucous membrane of the nasal cavities, extending as high as the base of the skull.

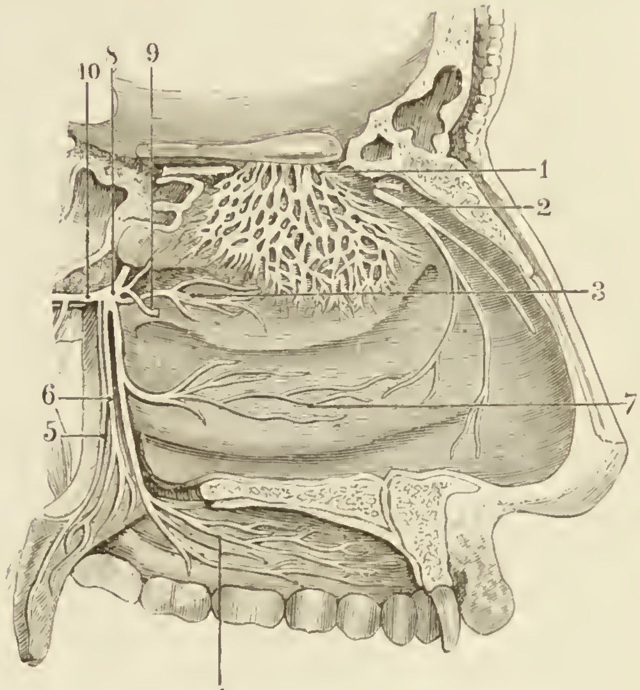


Fig. 130.—Distribution of Nerves over interior of Nostrils (outer wall).

1, Branches of nerves of smell—olfactory nerve; 2, nerves of common sensation to the nostril; 4, 5, 6, nerves to the palate springing from a ganglion at 3; 7, 8, 9, branches from one of the palate nerves to nasal cavities; 10, communication with facial nerve.

The **Nose** is formed of bone, cartilages, muscles, mucous membrane, vessels and nerves. The bones taking part in its formation are the nasal bones (the bridge of the nose) and the nasal processes and nasal spine of the upper jaw. The cartilages are two pairs, upper and lower nasal cartilages, and, small bits of the same tissue filling up the intervals between them. The **nostrils** are the anterior openings of the nasal cavities, they overhang the mouth, and are directed downwards, being separated from each other by a prolongation of the nasal septum.

The **Nasal Cavities** are placed in the middle of the bones of the face, and are separated from each other by a septum formed by the central plate of the ethmoid bone, the vomer, and a triangular plate of cartilage. The roof of the cavities is formed by the cribriform plate of the ethmoid bone and the sphenoid, so that in front, only the thin layer of the former

(not more than $\frac{1}{8}$ inch thick) separates these cavities from that for the brain. The sides are formed by the upper jaw-bones, the lachrymals, and palates, and the floor by the palate plates of the upper jaws and palate bones. At the back of the nose each cavity opens into the upper part of the pharynx by an oval aperture immediately above the soft palate, and in this way the throat, nose, and mouth communicate. On each lateral wall are three scroll-like bones (turbinated bones), the two upper forming part of the ethmoid, and the lower one being an independent bone. They serve to increase the extent of mucous membrane, and thus provide for the warming and moistening of the air before it passes into the lungs.

Opening into the nasal fossæ are irregular cavities in the upper jaw (the antrum), ethmoid, and sphenoid bones; they are lined with mucous membrane continuous with that of the nose, and the air passes into them in respiration. The mucous membrane of the nose is called the **Schneiderian membrane**. Only that part of it above the lower edge of the middle turbinated bone is endowed with the faculty of smell; it is of a darker colour than the rest, is covered by columnar non-ciliated cells, and has in it the olfactory nerves terminating in **olfactory cells**. The latter have an oval central part and a long tapering process at each end. One process projects beyond the surface level of the epithelium, like a bristle, and is probably caused to vibrate by the substance smelled; the other process passes to the deep part of the mucous membrane to join the termination of a branch of the olfactory nerve.

The lower part of the nasal cavities has nothing to do with the sense of smell, but is respiratory in function; the mucous membrane is covered by ciliated columnar cells, and contains a considerable number of mucous glands which by their secretion serve to keep the membrane moist.

Organ of Vision—The Eye and its Appendages.—The **Eye** is contained in the orbit or eye-socket, a description of which will be found on page 42. The cavity is occupied by fine fat, in which the eye, its muscles, vessels, and nerves lie embedded. This allows of the free movement of the eye-ball,

and protects it from injury on all sides but one, namely, the front. In illness much of the fat gets absorbed, and this explains the sunken appearance the eyes then present.

The **Eyelids** are two folds or lappets which serve to cover the eyeball in sleep and to protect it during waking. They are covered externally by very thin skin, and internally are lined by mucous membrane; between these a condensed fibrous

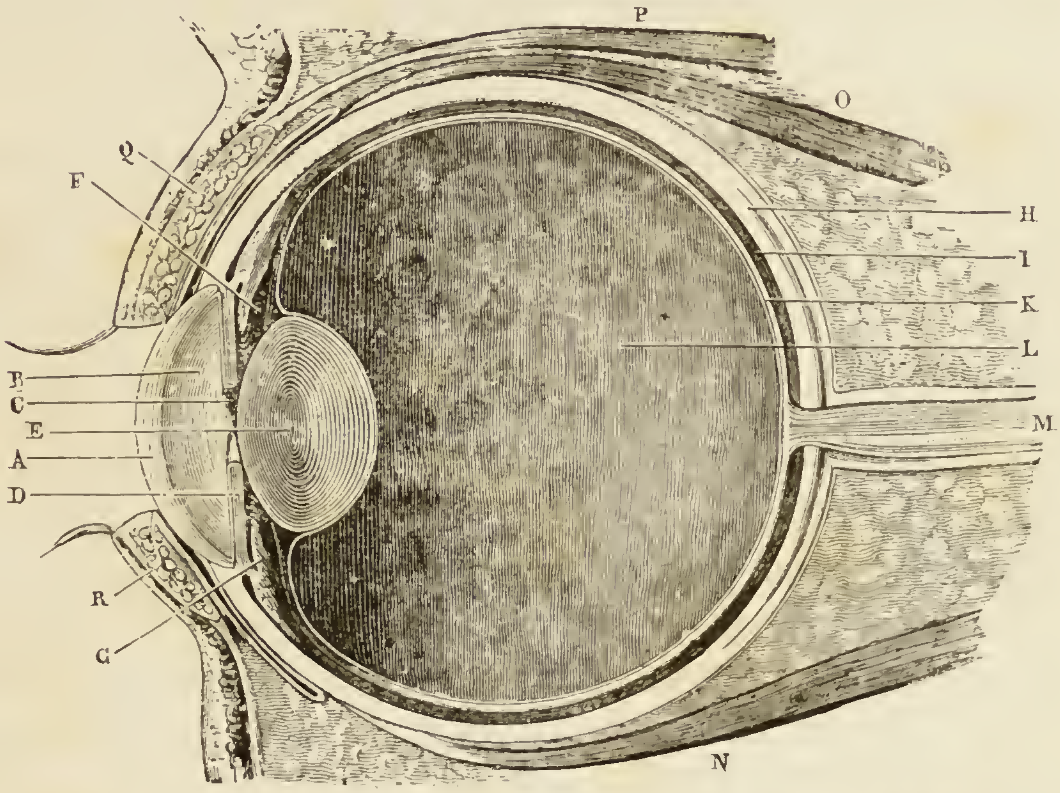


Fig. 131.—Representation of a vertical cut through the Eyeball in its Socket.

A, Cornea; B, anterior chamber; C, pupil; D, iris; E, crystalline lens; F, suspensory ligament; G, ciliary process; H, sclerotic; I, choroid; K, retina; L, vitreous humour; M, optic nerve; N, inferior rectus muscle; O, superior rectus muscle; P, elevator muscle of the upper lid; Q, upper eyelid; R, lower eyelid.

layer (erroneously spoken of as the tarsal *cartilage*) serves to maintain the shape of the lids. Inside this layer there is a row of glands, having long narrow ducts, which open on to the margin of the eyelids. These are the **Meibomian glands**; they serve to lubricate the edge of the eyelids. Towards the front of the free edge of the lids are placed the eyelashes; these are short hairs which curve upwards in the upper and downwards in the lower lid. The mucous membrane lining the lids is named the **conjunctiva**. It is very adherent to the inner surface of the lids, and is there pinkish in colour; it forms a

loose fold where it is reflected from the lids to the eyeball, and foreign bodies (dust, &c.) are very liable to become lodged in the sac thus formed. The conjunctiva passes over the eyeball till it reaches the clear transparent part—the cornea—when it becomes adherent again, and formed only of epithelial cells, which are inseparable from the underlying corneal tissue.

Besides the structures thus described, the eyelids contain the muscular fibres of the orbicularis palpebrarum muscles, which, when brought into action, close the eyes; they also contain blood-vessels and nerves.

The **Tear gland (lachrymal gland)** is placed at the upper and outer part of the eye-socket, occupying a hollow in the frontal bone, and resting on the upper part of the eye. It is a racemose gland and is formed of lobules, each made up of a number of vesicles lined with epithelium, and emptying by a number of ducts. These open on to the surface of the conjunctiva beneath the upper eyelid, and the tears secreted by the gland pass from these ducts across the front of the eye to the inner corner. Here they are gathered up by a small opening near the inner end of each eyelid, and carried by minute canals into a sac (**lachrymal sac**), lying in the groove of the lachrymal bone at the inner side of the orbital cavity. From the sac the tears are carried into the nose by a wide canal—the **nasal duct**. This communication of the mucous surface of the eye with that of the nose explains how readily inflammation spreads from the latter to the former in measles, and other affections involving the nose, and also accounts for the increased nasal flow when persons are moved to tears.

The **Eyeball** is spheroidal in shape, but is of rather less measurement from before backwards than from side to side. It has three coats or tunics: the outer or supporting coat called the **sclerotic**; the middle or vascular coat—the **choroid**; and the inner or recipient coat—the **retina**.

The **Sclerotic** is somewhat thicker behind than in front; it has a white, opalescent appearance, giving rise to the phrase "the white of the eye", and is formed of white fibrous tissue arranged in numerous layers in the interstices of which are

a few branched connective tissue cells. In front, this layer becomes modified so as to form a clear, transparent window—the cornea—through which light is transmitted to the interior of the eye. The **Cornea**, like the rest of the outer coat, is formed of connective tissue, but contains a very large number of connective tissue cells, and these are much branched and lie in spaces in the corneal substance; it is this character which renders the cornea transparent, while the sclerotic (formed of the same material) is opaque.

The **Choroid Coat** (the second tunic of the eye) is essentially a vascular coat, being made up of plexuses of arteries, veins, and capillaries. In the meshes of these are numerous branched cells loaded with pigment. In front, about opposite the point where the sclerotic passes into the cornea, the choroid forms a series of ridges or folds surrounding the crystalline lens, these are called **ciliary processes.** They contain blood-vessels and nerves in large quantity, and are deeply pigmented, but are further distinguished by the presence of unstriped muscular fibre in their substance, forming the **ciliary muscle**, by the action of which the accommodation of the eye is effected.

Fig. 132.—Different Kinds of Pigment Cells from Choroid and Retina of the Eye.

Passing from the front of the ciliary processes is the iris, which may be regarded as a further continuation of the choroid. The **iris** is the coloured part of the eye and forms a transverse partition dividing it into two chambers, the small anterior part between the iris and cornea forms the **anterior chamber**, and is occupied by a thin, watery fluid, the **aqueous humour**; the part behind the iris forms the **posterior chamber** and contains the crystalline lens and vitreous humour. In the centre of the iris is a circular opening, the **pupil**, which has the appearance of being a black spot; it is to allow of the transmission of light to the interior of the eye. The iris has a

framework of connective tissue with most of the fibres running from the circumference towards the centre and forming radiating pillars, the posterior surface is covered by pigmented cells, and in dark eyes (brown or black) the pigment also passes into the several layers of the iris. In its substance are bundles of involuntary muscular fibres, arranged in two sets; one runs round the edge of the iris where it forms the pupil, and serves by its contraction to narrow the opening; the other set radiates from the pupil to the circumference of the iris and by its contraction dilates the opening.

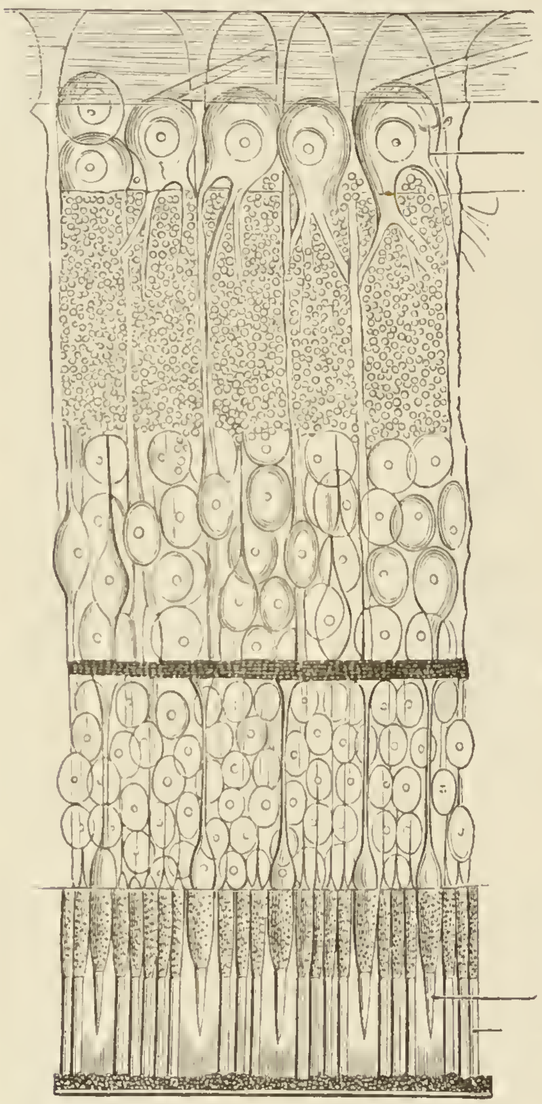


Fig. 133.—The Microscopic Structure of the Retina.

The inner coat of the eye is called the **Retina**. It exists as a very delicate film, lining the interior of the eye, and is in the living person of a purplish tint, but in the dead eye is greenish gray. At the back of the eye it is firmly fixed by means of the fibres of the optic nerve, which enter it and form a large part of its structure; here it is thickest, becoming gradually thinner as it passes forwards, and terminating in a festooned edge (ora serrata) behind the ciliary processes. In the optical axis of the eye, and a tenth of an inch to the outer side of the optic nerve entrance, is a spot which is at once the most sensitive and the thinnest part of the retina; it is the **yellow spot** or **macula lutea**. Although very thin, the retina is made

up of many layers, and is so complicated in structure that only a general description will be here attempted. On the side of the retina next to the choroid is a layer of six-sided, granular, nucleated cells, filled with pigment; these were formerly described as belonging to the choroid coat, but are now regarded as retinal. The next layer to this consists of peculiar bodies called **rods** and **cones**, the rods greatly predominating in the retina generally, but the cones being alone present at the yellow spot. To this succeeds a layer of nuclear bodies connected with each other and with the previous layer by fine fibres; many of these are connected directly with the bases of the rods and cones. Next comes a narrow layer of fine granules (outer granular layer), succeeded by a second nuclear layer, and this again by a second and much thicker granular layer. The two internal layers of the retina are a layer of nerve-cells and one of nerve-fibres, the latter being most internal, and separated from the vitreous humour only by a thin limiting membrane. Fine fibres pass through the retina from the rods and cones to the inner layers, and have some connection with the other elements as they pass through them. It is supposed that light causes the rods and cones to vibrate, and that the motion is transmitted by these fibres to the nerve-cells and nerve-fibres, and by them the sensation is carried to the brain. The optic nerve entrance is totally devoid of rods and cones, and is quite insensitive to light. In the macula the rods are absent, but the cones are numerous, elongated and compressed; the other layers are much reduced in thickness and the nerve-fibres are absent. The blood-vessels of the retina enter or leave the eye through the centre of the optic nerve, and ramify in the two inner layers of the retinal structure.

Behind the iris is placed the **Crystalline Lens**, having the form of a biconvex lens, with the anterior surface more flattened than the posterior. It is perfectly transparent in health, and when it becomes opaque from senile changes or injury constitutes the condition known as **cataract**. The lens is itself elastic, and is contained in an elastic **capsule**, and is thus

able to change its shape and convexity in the act of accommodation of the eye for near and distant objects. In front the iris lies against it, and the anterior surface is bathed by the aqueous humour; behind, it is supported by the front of the vitreous humour. It is held in its place by an elastic **suspensory ligament** passing from its margin to the choroid, behind the base of the ciliary processes. The **ciliary muscle** has been described as forming part of the structure of the ciliary process; it is placed at the junction of the cornea, sclerotic, and choroid. By its contraction it draws forwards the posterior attachment of the suspensory ligament of the lens, relaxes that ligament, and thus frees the lens from its pressure, and allows the latter to become more convex. This is what takes place when near objects are looked at.

The greater portion of the interior of the globe of the eye is occupied by the **Vitreous Humour**. This is a very soft, jelly-like modification of connective tissue, enclosed in a thin transparent capsule, the **hyaloid membrane**, and serving to maintain the shape of the eye and permit the rays of light to reach the retina.

The **nerves** passing to the eyeball are the third nerve, nasal branch of the fifth, and sympathetic. The arteries are branches of the ophthalmic.

The Organ of Hearing.—The **ear** or organ of hearing is divided into three portions—the external ear, the middle ear, and the internal ear.

The **External ear** consists of the auricle, and the meatus, or channel passing inwards to the middle ear. The **auricle**, the expanded part of the ear, is formed of cartilage, on which lie several rudimentary muscles, and is covered by thin and delicate skin. Dependent from the lower part is the **lobule**, formed of fibrous tissue and fat, and which in savage and civilized races alike serves for the attachment of ornaments. The **meatus**, or opening of the ear, is a short canal passing inwards and slightly forwards; it is oval in shape, narrower in the centre than at either end, and its floor rises a little in the middle. Small hairs jut out into the lumen of the canal, and

a number of glands pour out the secretion of cerumen (or wax) on to the skin lining it. At the inner end of this opening is placed the **drum of the ear** or **membrana tympani**.

Middle Ear.—This is formed by a cavity contained in the temporal bone, at the bottom of the meatus, and called the **tympanic cavity**. At its outer side is the **drum** or **membrana tympani**, completely separating off the cavity from the meatus.

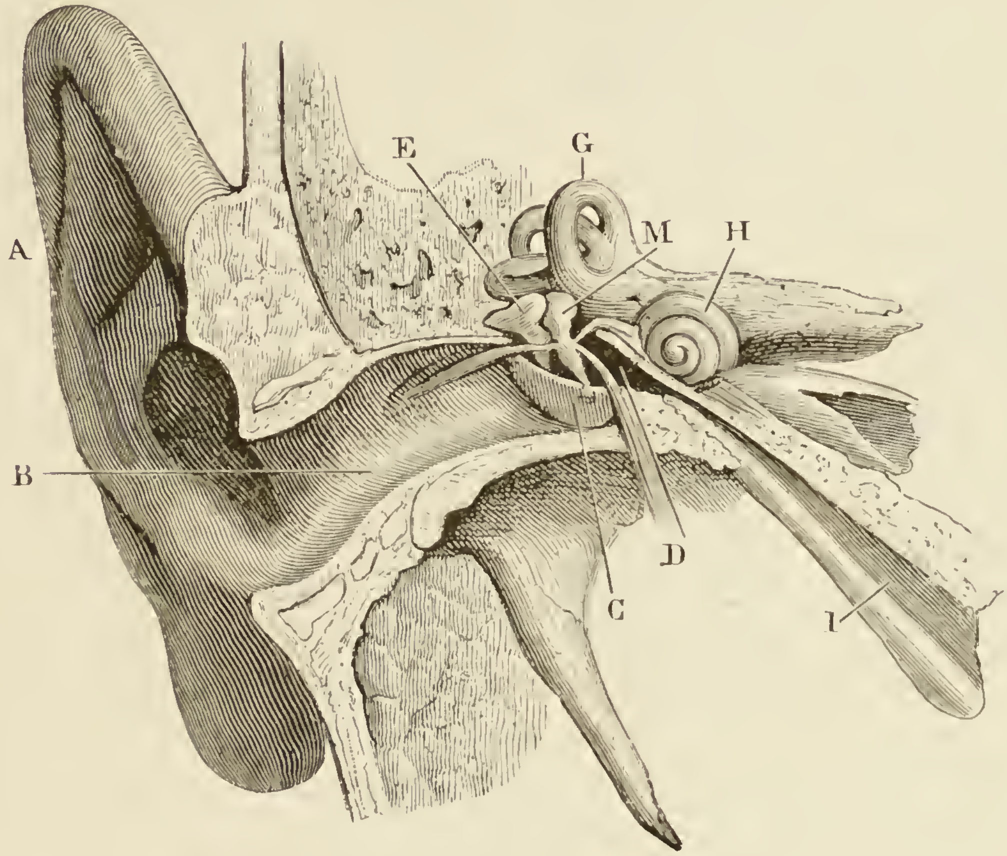


Fig. 134.—The Ear of the Right Side.

A, Auricle; B, external meatus; C, drum, partly removed; D, cavity of tympanum; E, incus, and M, malleus—small bones of the middle ear; H, cochlea, and G, semicircular canals of internal ear. [These latter parts are buried in the temporal bone of the head.] I, Eustachian tube passing from the cavity of the middle ear to the throat.

The drum is a thin, oval membrane, having a depression on the outer side near its middle, due to being drawn in by one of the little bones of the ear, the malleus or hammer, the handle of which is attached to it. The inner wall of the tympanic cavity is irregular, and has on it two openings called fenestræ (windows). One of these is oval in shape (**fenestra ovalis**), communicates with the vestibular cavity, and is occupied by the foot of the stapes or stirrup-bone; the other is round (**fenestra rotunda**), and communicates with one of the staircases of the cochlea.

Behind, the tympanic cavity has opening into it some air cavities in the mastoid, the **mastoid cells**; in front, it is placed in communication with the upper part of the throat by means of the Eustachian tube. In consequence of the latter connection the mucous membrane of the tympanic cavity is continuous with that of the nose and throat, and it is in consequence of this that middle-ear disease is so common after scarlet fever.

A chain of small bones crosses the cavity, and is connected on the outer wall with the drum, and on the inner with the fenestra ovalis; these are the **malleus** or **hammer**, the **incus** or **anvil**, and the **stapes** or **stirrup**. They are seen in their proper relative position in the lower figure of fig. 135, where 1 is the malleus and 2 its handle; 3 the incus with 4, its long process, passing to articulate with 5, the stapes. The handle of the malleus (2) is attached to the drum, and when that is vibrated by waves of sound the motion is transmitted to the malleus, thence to the incus, by which it is passed on to the stapes, the latter is consequently driven into the fenestra ovalis. But that opening is closed by a thin membrane, and when the stirrup is moved this is driven in towards the internal ear containing the delicate nerve apparatus, which is thus acted on.

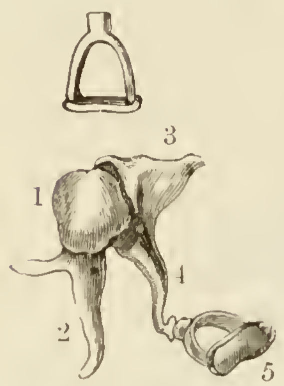


Fig. 135.—Ear-bones.
1, Head of malleus; 2, handle of the malleus; 3, short process of incus; 4, long process of incus; 5, stapes.

In connection with the three small bones are three diminutive muscles. One of these, the **tensor tympani**, is inserted into the malleus near the root of the handle and by drawing the middle of the drum inwards makes it tense. A second muscle attached to the malleus is the **laxator tympani**; it opposes the action of the previous muscle, and relaxes the drum. The third muscle, called **stapedius**, is connected with the neck of the stirrup, and serves to limit the movement of that bone, and prevent its being driven too forcibly into the fenestra ovalis.

The cavity of the tympanum is crossed by the chorda tympani nerve, coming from the facial and going to the tongue. At the upper part of the inner wall is the facial nerve con-

tained in the aqueduct of Fallopius; its position in relation to the middle ear explains how it is that facial paralysis sometimes follows on ear disease.

Internal Ear.—The internal ear is entirely enclosed in the petrous portion of the temporal bone. The densest part of the bone is excavated into cavities and canals, communicating with each other, and occupied by fluid in which membranous structures float. The suggestive name of **labyrinth** is given to the cavities of the internal ear, and the existence of sacs within the bony canals leads to the structures as a whole being described under the two heads of the osseous labyrinth and the membranous labyrinth.

Fig. 136.—Bony Internal Ear of the Right Side; the upper figure magnified; the lower of the natural size.

2, Fenestra ovalis; 3, superior semicircular canal; 4, external semicircular canal; 5, posterior semicircular canal; 6, communication between cochlea and vestibule; 7, 8, cochlea; 9, fenestra ovalis. The asterisks mark the dilatations or ampullæ of the semicircular canals.

The **Osseous labyrinth** consists of the cavities in the bone; they are the **vestibule** in the middle, the **cochlea** in front, and the **semicircular canals** behind. The **vestibule** is an oval cavern, communicating on the outer side with the tympanic cavity by the fenestra ovalis (fig. 136, 2), the opening of which is, however, blocked by the foot of the stapes. On the inside the vestibule has the internal auditory meatus, and receives filaments from the auditory nerve as it lies in that canal. Behind, it opens into the semicircular canals, and in front communicates with the cochlea. The **semicircular canals** are three in number, and are connected at each end with the vesti-

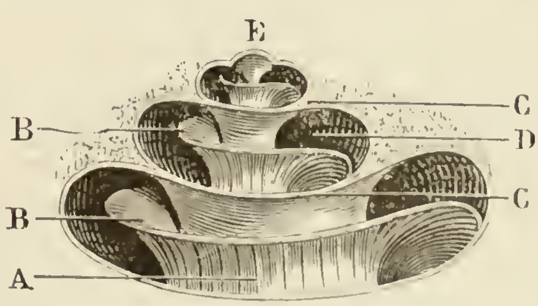


Fig. 137.—The Cochlea opened up (magnified).

A, modiolus; B, osseous division between the staircases; C, scala tympani; D, scala vestibuli; E, dome of the cochlea.

bule, but as two of the canals unite by one of their ends there are only five openings into that cavity. Near the commencement of each canal is a spherical dilatation, called an **ampulla** (fig. 136). The **cochlea** is so called from its resemblance to a snail's shell. It is formed by a spiral canal passing round a central shaft, the **modiolus**. A bony septum juts out from the latter—the **osseous spiral lamina**—and partly divides the cavity of the cochlea into channels, the division being completed by a membranous partition. Each channel so formed is called a **scala** (*staircase*); the upper one, named **scala vestibuli**, commences at the vestibule, takes two and a half turns round the modiolus, narrowing as it ascends, and at the summit of the cochlea opens by a small aperture (the *helicotrema*) into the other staircase, the **scala tympani**. The latter takes two and a half turns round the modiolus, and ends at the fenestra rotunda, an opening communicating with the tympanum, but closed by a membrane. The osseous labyrinth contains a fluid, called **perilymph**, in which the structures forming the membranous labyrinth float.

Fig. 138.—The Membranous Labyrinth.

a, Superior membranous semicircular canal; *b*, posterior canal; *c*, external canal; *d*, utricle; *e*, saccule; *f*, canal connecting the saccule with the cochlea; *g*, membranous lamina spiralis of the cochlea.

The **Membranous labyrinth** is formed by the membranous structures contained in the osseous labyrinth. The **Vestibule** contains two membranous sacs, a large one, the **utricle**, and a smaller one, the **saccule**. The utricle communicates with the membranous semicircular canals, the saccule with a small canal in the cochlea. The membranous semicircular canals are like the bony canals in shape, but are much smaller; they have dilatations in the ampullæ. The inner surface of these membranes is lined by epithelial cells, and has projecting from it fine hair-like processes, which float in a thin fluid called **endolymph**, with which the membranes are filled. Branches of the auditory nerve pass to the sacs in the vestibule and membranous canals, and are supposed to end in the hair-

like processes. Inside the utricular sac, and closely adherent to its wall, are minute crystals of carbonate of lime, named **otoliths**, the use of which is not well understood.

The **membranous part of the cochlea** is the most important and complicated part of the internal ear. It has been mentioned that the osseous partition between the two scalæ is incomplete, and that the gap is filled up by the membranous apparatus of the cochlea. Fig. 139 shows that in the process of completing the septum a third canal is formed; this is the **scala media** or **canal of the cochlea.** This canal extends from the base to the apex of the cochlea, lying between the scala tympani and scala vestibuli, but not communicating with either; it terminates above in a *cul de sac*, and below is connected with the saccule by means of a very fine canal (**canalis reuniens**) (fig. 138, *f*). It is separated from the cavity of the scala vestibuli by a thin membrane, the **membrane of Reissner** (fig. 139, 2), and from the scala tympani by a thicker and stronger layer, the **basilar membrane** (1). Within the scala media, and resting on the basilar membrane, is a very complicated apparatus called the **organ of Corti** from the Marquis of Corti, who first described it. The most peculiar and important elements of it are a number of fibres or rods—**Rods of Corti**—arranged in pairs. Each pair consists of an inner and outer rod, placed so as to form an acute angle between them, and likened to

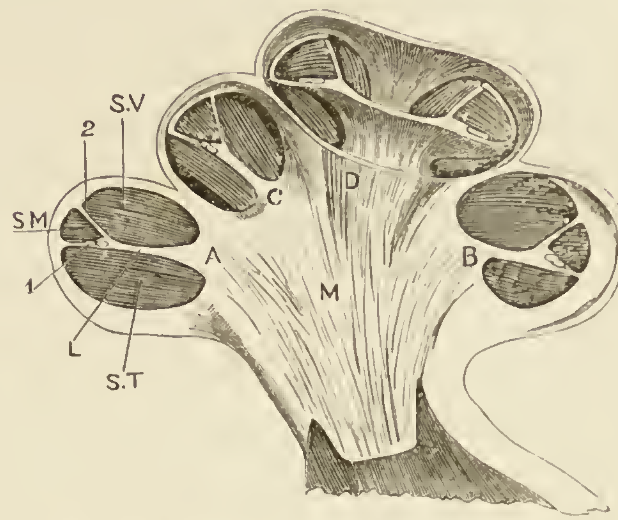


Fig. 139.—Vertical Section of the Cochlea of a Fœtal Calf.

A, B, C, and D, The osseous lamina spiralis; M, modiolus; SV, scala vestibuli; ST, scala tympani; SM, scala media; L, lining periosteum; 1, basilar membrane; 2, membrane of Reissner.

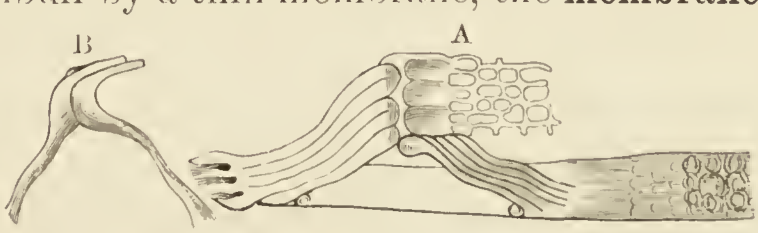


Fig. 140.—Arches of Corti's Organ (very highly magnified).

A, Shown in their place, resting on the basilar membrane; B, two rods separated from their connections.

the gable-end of a house. When looked at from above they resemble the keys of a piano. It has been estimated that in the human ear there are not less than 3000 of these arches. The rods support a number of modified epithelial cells, those on the side towards the modiolus being largest and most numerous, and filling up a hollow in the edge of the lamina spiralis. From the upper surface of the inner cells there project bundles of stiff hairs; these pass through openings in a **fenestrated membrane**, which covers the cells. The bases of the cells are intimately connected with the ends of the cochlear branches of the auditory nerve, which reach the organ of Corti by passing through the centre of the modiolus. It is stated by some authorities that the hair-cells are the true terminal organs of the auditory nerve; others consider the rods of Corti to occupy that position.

SPLANCHNOLOGY.

THE VISCERA OF THE BODY.

The **Viscera** of the body are situated in the great cavities—the cranio-spinal axis, chest, abdomen, and pelvis. The viscera of the first of these, namely, the brain and spinal cord, have been already described. Those of the chest are the heart and lungs; the first of these has been already described. The viscera of the abdomen are the alimentary canal, liver, spleen, pancreas, kidneys, and supra-renal bodies. Those of the pelvis, the urinary bladder and organs of generation.

The Organs of Respiration and Voice.—The organs of respiration are the two lungs connected together by the windpipe or trachea. The upper part of the trachea is modified to form the voice-box or larynx.

The Larynx.—The **Larynx** or voice-box is placed at the upper part of the windpipe immediately below the tongue, with which also it is closely connected. It is seen and felt a little below the jaw, where it forms a prominent projection known as the *pomum Adami* or Adam's apple. It is formed of cartilages, muscles, and ligaments, is lined by mucous membrane, and is freely supplied with vessels and nerves.

The largest of the cartilages is called **thyroid**, from a supposed resemblance to a shield (Gk. *thyreos*, a shield). It is formed of two curved plates or wings joined together in front, but separated by a wide interval behind. At their upper part in front they form by their union the projection already mentioned as the *pomum Adami*. From the back part of each wing a process passes upwards (**superior cornu**) and another downwards (**inferior cornu**). The former is loosely connected with the hyoid bone by a ligament; the latter is articulated by a true joint with the cricoid cartilage, and forms the hinge on which the thyroid moves. This articulation allows of the thyroid moving upwards and downwards on the cricoid, but not from

side to side. The **cricoid cartilage** is shaped like a signet-ring, and is very narrow in front but deep and strong behind. The broad posterior part helps to fill the space between the two wings of the thyroid. The part in front is so narrow that an interval is left between it and the thyroid, which in the living person is closed by membrane; it is through this space that the air-passage is opened in the operation of laryngotomy, for the relief of obstruction to the breathing. Tracheotomy, again, consists in opening into the windpipe (trachea) below the larynx. At the back and upper part of the cricoid cartilage is a slightly-flattened surface for the support of a pair of very singular cartilages of a pyramidal form, called the **arytenoid cartilages.** They are capped by little horn-like projections and give attachment by their anterior angles to the true vocal cords, and by their outer angles to the muscles which open and close the glottis, or upper opening of the windpipe. Immediately behind the pomum Adami is a cartilage shaped like a leaf, and attached by a narrow neck to the inner surface of the thyroid cartilage; it is the **cartilage of the epiglottis**, and is composed of elastic cartilage, whereas the others named above are of white hyaline cartilage. The **epiglottis** forms a lid for the opening of the windpipe, closing down over it during swallowing, and thus preventing the food from going into the air-passages. It is connected to the tongue by three folds of mucous membrane (*glosso-epiglottic folds*), and with the arytenoid cartilages by other folds (*ary-epiglottic folds*), and its motion is controlled by muscles and fibrous bands passing to

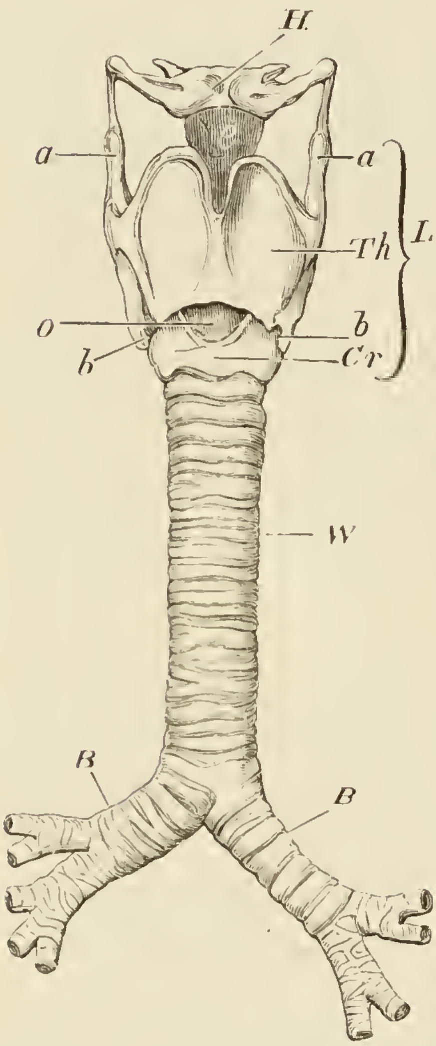


Fig. 141.—The larynx (L); windpipe (W); and bronchi (BB); *e*, epiglottis; *Th*, thyroid cartilage; *Cr*, cricoid cartilage, forming L the larynx; *a*, superior cornu of thyroid; *b*, inferior cornu; O, crico-thyroid space; H, hyoid bone.

it from the hyoid bone and thyroid cartilage. It has a covering of mucous membrane, in which are numerous glands.

The hyoid bone and thyroid cartilage are maintained in their proper relative position by a broad band of white fibrous tissue (*middle thyro-hyoid ligament*) and two slender cords of yellow elastic tissue.

The thyroid and cricoid are connected, by **capsular ligaments** surrounding the articulation of the inferior cornua of the former with the facets on the latter, and by an elastic membrane closing the crico-thyroid space.

Between the inner surface of the thyroid (close to the middle line) and the anterior angles of the arytenoid cartilages, are two pairs of ligamentous bands, the upper formed of white fibrous tissue, the **false vocal cords**, and the lower of yellow elastic tissue, the **true vocal cords**. The latter form elastic strings whose length and tension can be regulated by the muscular apparatus of the larynx, and consequently can be made to produce a considerable range of musical notes; they thus form the essential structures of the voice-box. The **arytenoid cartilages** are articulated with the cricoid cartilage by means of two capsular ligaments, forming a joint of the arthrodial variety.

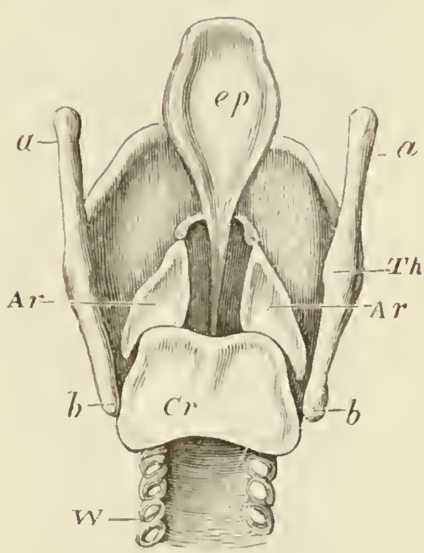


Fig. 142.—The Larynx (from behind), the soft parts being removed.

ep, epiglottis, capable of folding down on the entrance to the larynx like a lid and so closing it. *Th*, thyroid cartilage; *Cr*, cricoid cartilage; *Ar*, arytenoid cartilages; *W*, windpipe; *a a*, superior cornua of thyroid; *b b*, inferior cornua of thyroid.

The **muscles of the larynx** are complicated, and all attempts to simplify the description of them have hitherto failed. One of the chief pairs of muscles is placed on the outside of the larynx; as each muscle passes from the upper edge of the front of the cricoid cartilage to the lower border of the wing of the thyroid, they have been named **crico-thyroid**. Taking their fixed point from below they draw down the thyroid upon the cricoid, and cause the vocal cords to be approximated and rendered tense. Another pair of muscles (**crico-**

arytenoideus posticus) is placed at the back of the cricoid cartilage; each muscle passes outwards to reach the outer angle of the arytenoid. When acting, these muscles open the glottis to the widest possible extent; this taking place when a full inspiration is made. The next pair of muscles pass from the lateral part of the cricoid on each side to the outer angle of the arytenoid (**crico-arytenoideus lateralis**); these antagonize the previous pair, as they bring the vocal cords together and close the glottis. Thin but very important bands of muscle pass on the outer side of the two true vocal cords and parallel with them; these muscles — the **thyro-arytenoid** — modify the tension of the cords and are brought into play in the production of voice and musical notes. Muscular fibres also pass between the arytenoid cartilages and the epiglottis, and between the thyroid cartilage and epiglottis; they serve to draw down the latter structure during swallowing, and also are effective in changing the shape of the upper part of the larynx, so as to make it serve as an effective "resonance-chamber".

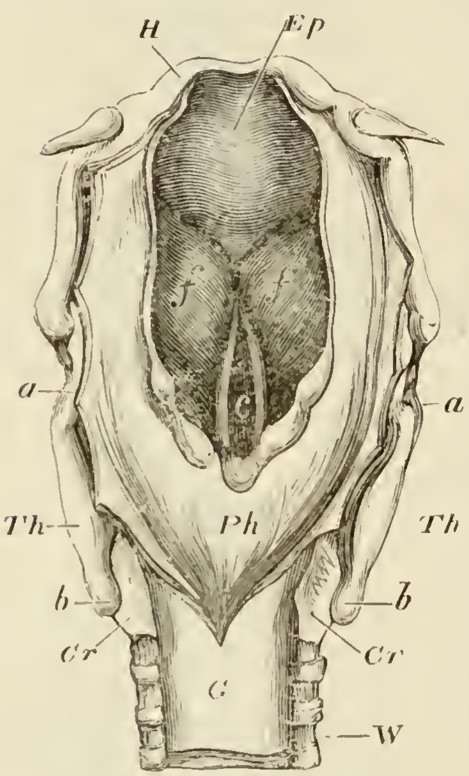


Fig. 143.—View of Larynx from behind, with all the soft parts.

f, False cords; *c*, placed in chink of the glottis, is between the true vocal cords; *Ph*, pharynx; *G*, gullet; *H*, hyoid bone; *Ep*, epiglottis; *Th*, thyroid cartilage; *Cr*, cricoid cartilage; *a* and *b*, superior and inferior cornua of thyroid cartilage; *W*, windpipe.

The whole of the larynx is lined by delicate **mucous membrane**, covered for the most part with columnar ciliated epithelium; but on the true vocal cords the membrane is very thin and adherent, and has only a single layer of non-ciliated squamous epithelial cells.

Interior of the Larynx. — The interior of the larynx is constricted at its lower part by the bands already described as the false and true vocal cords, and has therefore somewhat the shape of an hour-glass. The **lower** or **true vocal cord** appears as a white or faintly-yellow cord. The **false cord**

does not approach so near to the middle line, and is pink in colour, and the mucous membrane covering it is thick and loose; the epithelium is columnar and ciliated. Between the false and true vocal cords is a space called the **ventricle of the larynx**, and this leads into a cavity outside the false vocal cords, the **saccule of the larynx.** The upper opening of the larynx is shaped like the ace of clubs, and is bounded in front by the epiglottis, at the sides by folds of mucous membrane called the ary-epiglottic folds, and behind by the arytenoid cartilages and the mucous membrane between them. The **mucous membrane** lining the larynx is lubricated by the secretion of a large number of glands. They are especially plentiful in the saccule of the larynx, and the fluid formed by them is directed to the surface of the true vocal cords.

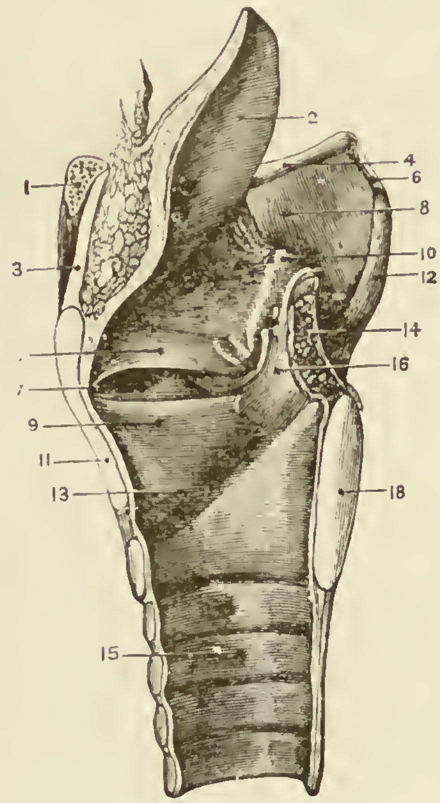


Fig. 144.—Vertical Section of Larynx.

1, Hyoid bone; 2, epiglottis; 3 and 8, thyro-hyoid membrane; 4, great cornu of hyoid; 5, false vocal cord; 6, thyro-hyoid ligament; 7, ventricle of larynx; 9, true vocal cord; 10, ary-epiglottic fold; 11, thyroid cartilage; 12, superior cornu; 13, crico-thyroid membrane; 14, muscle of arytenoid cartilages; 15, trachea; 16, arytenoid cartilage; 18, cricoid cartilage. [Wilson.]

The constriction of the larynx caused by the approximation of the vocal cords is called the **glottis**, or **rima glottidis**, and the name of **cavity of the glottis** is given to that part of the air-passage extending from the glottis to the edge of the ary-epiglottic folds.

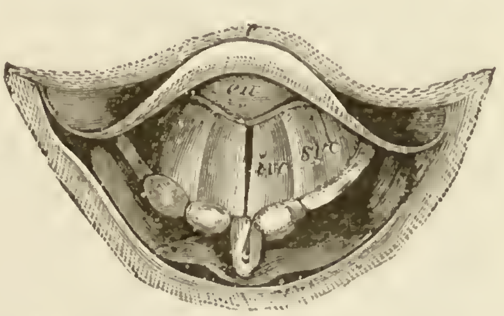


Fig. 145.—View of the Interior of the Larynx as seen with the Laryngoscope. For description see text.

Vessels and Nerves.—The arteries of the larynx are derived from the superior and inferior thyroid arteries. The nerves are the superior and inferior (or recurrent) laryngeal branches of the vagus, the former being the sensory and the latter the motor nerve.

Laryngoscopic Appearance.—When examined with the laryngoscope the larynx presents the appearance shown in fig. 145, where *e* denotes the epiglottis, *cu* a cushion-like pad at the root of the epiglottis, *i. v. c.* the true vocal cord, *s. v. c.* the false vocal cord. The ary-epiglottic folds are shown forming a crescent behind the vocal cords, and presenting nodular eminences due to the projection of the arytenoid and cuneiform cartilages.

The Trachea.—The **Trachea** or windpipe extends from the lower border of the larynx, opposite the body of the sixth cervical vertebra, to the fourth dorsal vertebra; it there divides into the two bronchi, one for each lung. It is about four inches in length and is nearly an inch wide. It is rounded in front but is flattened behind and rests upon the front of the gullet. The anterior convex portion is formed of incomplete cartilaginous rings, joined together by fibrous membrane. They serve the purpose of preventing the closure of the tube, and consequently provide for free access of air to the lungs. The interval between the rings at the back is occupied by muscular tissue and a little connective tissue; the muscular fibres for the most part run transversely, between the ends of the cartilages, but some are arranged longitudinally. The whole of the tube is lined by mucous membrane, furnished with a ciliated epithelium continuous with that of the larynx above and the bronchi below. There are a large number of glands beneath the mucous membrane, both at the back and sides of the windpipe, and these pour out a copious secretion on to the surface of the membrane, which serves to lubricate it.

The **Bronchi** are the two tubes—one for each lung—into which the windpipe divides. They bear a very close resemblance to the trachea, being convex in front, flattened behind, and having cartilaginous rings which are deficient behind, the gap being filled by muscular tissue. The right bronchus is shorter and more horizontal than the left, and being placed in more direct continuation with the trachea is generally the place where foreign bodies get lodged.

Thyroid Body.—In front of the trachea, and closely con-

nected with it, is a peculiar mass, spoken of as the **thyroid body**. It consists of two lobes of a triangular shape, placed one on each side of the windpipe at its upper part, and connected across its front by a narrow lobe, the **isthmus**. The thyroid body is composed of an aggregation of cavities or

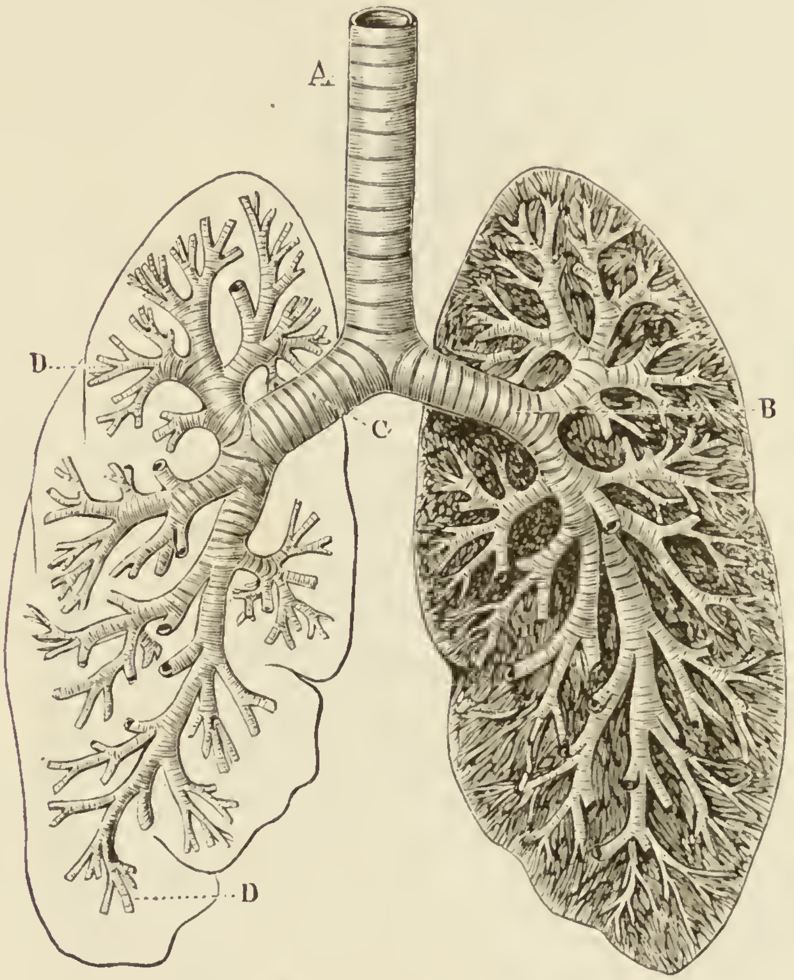


Fig. 146.—Air-tubes of the Lungs.

A, Trachea; B, left bronchus; C, right bronchus; D D, bronchial tubes.

vesicles, each lined by columnar epithelium and containing a clear yellowish fluid.

The enlargement of this body produces the condition known as *goitre* or *Derbyshire neck*.

The Lungs.—The **Lungs**, the organs of respiration, occupy the greater part of the thoracic cavity. They are two in number, the right being distinguished from the left by being shorter, broader, and heavier, and by being divided into three lobes. The left lung is longer but narrower than the right; it weighs about two ounces less, is divided into two lobes, and

has a notch on its anterior edge corresponding to the position of the heart. The upper end of each lung, called the **apex**, passes up into the lower part of the neck, ascending for about $1\frac{1}{2}$ inches above the collar-bone. The lower border or base rests upon the diaphragm, and is concave, to correspond with the convexity of that muscle. The posterior border is rounded and thick, and fills in the hollow at the side of the vertebral column; the anterior edge is thin and sharp, and overlaps the pericardium and heart.

Pleura.—The lungs are enclosed by a serous membrane, the pleura, which forms two entirely separate sacs, the **pleural cavities**. The pleura lines the chest wall and upper surface of the diaphragm, and from thence passes on to the pericardium, and from it to the root of the lung, in front and behind, above and below; it then covers the whole surface of the lung, becoming very closely connected with its substance. The pleural membranes secrete sufficient fluid to lubricate their surfaces, and there is thus secured smoothness of movement in the expansion and contraction of the lung in respiration. Inflammation of this membrane is called *pleurisy.*

Limits of the Lungs.—It will be understood from the above description that the limits of the pleural cavities nearly correspond with those of the lungs, but extend very slightly beyond the latter. The two pleuræ form dome-like prolongations into the neck, rising to one and a half inches above the clavicle. The two sacs meet together in the middle line of the breast-bone, opposite the cartilages of the second ribs, and lie together till they reach the level of the fourth costal cartilage. From this point the right pleural sac is continued down in the middle line to the level of the seventh rib; in the nipple line it reaches to the eighth rib, in the axillary line to the ninth rib, and behind, to the lower border of the eleventh, or upper border of the twelfth rib. The left pleura passes from the middle line at the level of the fourth rib, and reaches the lower edge of the seventh rib in the nipple line; in this way it leaves a portion of the front of the heart uncovered. It reaches to a lower level at the side and behind than the right pleura; in

the axillary line it touches the lower border of the tenth rib, and at the back often extends below the twelfth.

Each lung is entirely free in its entire circumference, excepting along its inner surface, where it is connected with the air-passages and heart by structures constituting its root, and

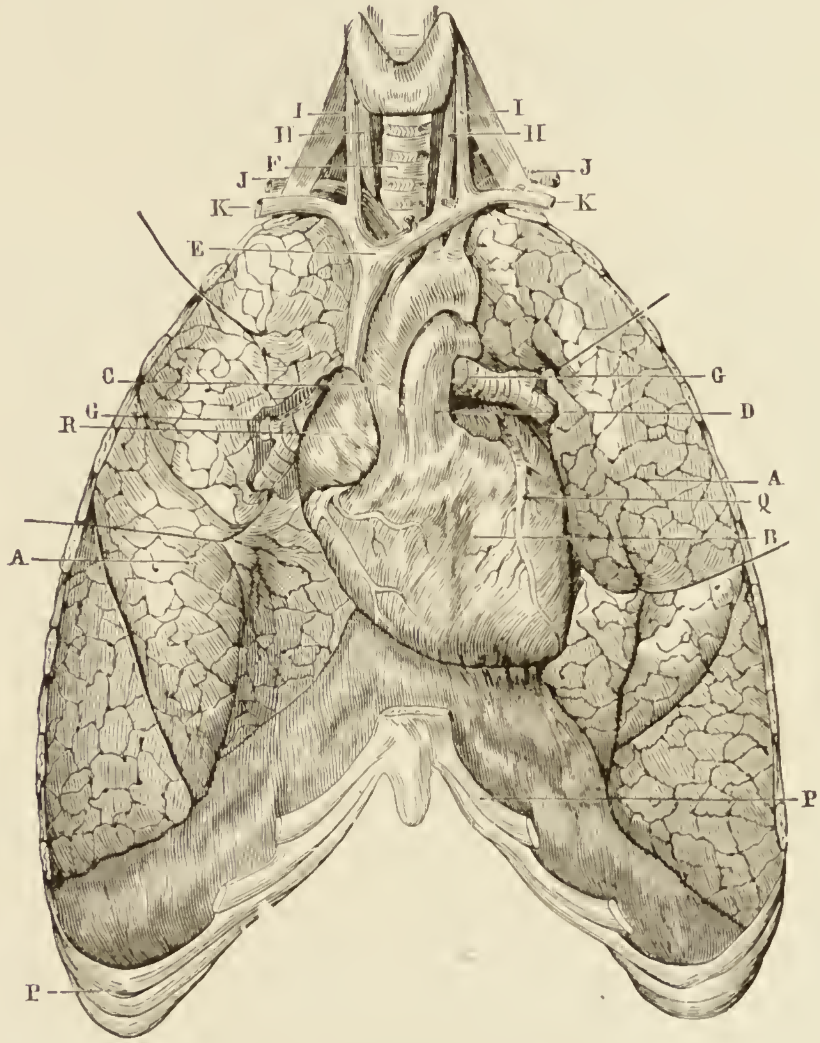


Fig. 147.—The Heart with its Blood-vessels and the Lungs.

A, The lungs pulled aside in front to show the heart, B, and the bronchial tubes, G, G; C, the aorta; D, the pulmonary artery; E, the superior vena cava, formed by the junction of the veins (innominate) from the right and left sides, K, K; F, the windpipe; I, I, veins from the head and neck (jugular) joining the subclavian veins; II, II, carotid arteries; J, J, subclavian arteries; P, P, ribs; Q, coronary artery; R, right auricle of heart.

by folds of pleura. The **root of the lung** is formed by the bronchus or air-passage, two pulmonary arteries, and two pulmonary veins; there also enter at the root the nerves and lymphatic vessels of the lung, and a number of lymphatic glands (bronchial glands) are also disposed around it.

Structure of the Lung.—The lung is of a mottled-pink

colour in young children, but in adults (and especially in the dwellers in towns) is the seat of extensive deposit of black pigment. The lung is composed of a great number of small **lobules**, the whole of which are almost identical in structure, so that each of them may be regarded as a lung in miniature. Each lobule has for its root or stem an ultimate branch of a bronchial tube, and this, on entering it, opens into an irregular passage, the **intercellular passage**, around which are grouped a number of cavities, the **air-cells** or **alveoli**, all of them com-

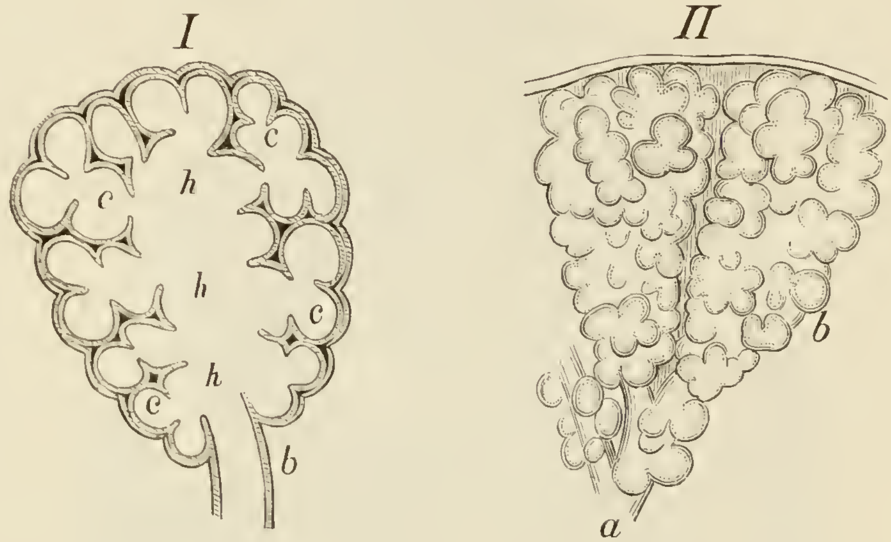


Fig. 148.—Air-cells of the Lung.

I, Terminal air-passages of the lung; *b*, bronchial tube; *c*, *c*, *c*, air-cells; *h*, *h*, *h*, intercellular passage. II, Lobules of a lung; *a*, bronchial tube; *b*, air-cells (from the lungs of a newly-born child).

municating freely with the passage and through it with the bronchus, but having no other openings. The walls of the air-cells are of extreme thinness, and are formed by connective tissue, chiefly of the elastic variety; they have ramifying in them an elaborate plexus of capillary vessels, by means of which the blood carried to the lungs by the pulmonary artery is exposed to the action of the air in the air-cells. The alveoli are lined by a single layer of thin cells, and there is thus interposed between the blood and the air only these cells and those forming the capillary wall. Each lobule has a branch of the pulmonary artery entering it, and a similar radicle of the pulmonary vein leaving it; it also receives lymphatic vessels and minute twigs of the pulmonary plexus of nerves. The lobules are joined together by connective tissue, and form by

their aggregation the **lobes** of the lung; on their free surface (that is to say, where they are not in contact with each other) they are covered by pleura.

The **Bronchial tubes** are composed of the same materials as the bronchi and trachea, but these are differently arranged. The cartilages are in the form of plates instead of rings, but they are disposed around the whole circumference of the tube, and the muscular fibres have a similar arrangement within the cartilages; the bronchial tubes are consequently cylindrical, and not flattened posteriorly like the trachea and bronchi. The walls of the intercellular passages and air-cells have neither cartilage nor muscular fibre entering into their composition.

The blood is brought to the lungs from the right side of the heart by the branches of the pulmonary artery; these terminate by forming the capillary plexus in the walls of the air-cells. From the same plexus the radicles of the pulmonary veins originate, and carry the aerated and purified blood back to the left side of the heart to be distributed to the body generally

The **capillary plexus** is the closest and most elaborate in the body; it consists for the most part of a single layer of vessels, so disposed in the wall of the air-cell that it is exposed to the air contained in two contiguous alveoli.

The lung contains a very large amount of elastic tissue, and the act of breathing out the air in respiration (expiration) takes place mainly by its contraction. When a lung is breaking down from disease—as, for instance, in the formation of a cavity in pulmonary consumption—elastic tissue is found in the patient's spit.

Thymus Body.—The **thymus** is a peculiar gland-like mass situated in the upper part of the chest and lower part of the neck in children. It increases in size till the child is two years old, remains stationary till the eighth year, then gradually diminishes in size, and by the age of thirty or forty is scarcely distinguishable. Very little is known as to its use in the animal economy.

Abdomen.—The **Abdominal Cavity** or **belly** is bounded above by the diaphragm, which separates it from the chest;

behind, by the vertebral column and some of the muscles of the back; below, by the pelvis; at the sides and in front, by the abdominal muscles, lower ribs, costal cartilages, and xiphoid cartilage of the sternum. It contains the alimentary canal, liver, pancreas, spleen, kidneys, and supra-renal bodies.

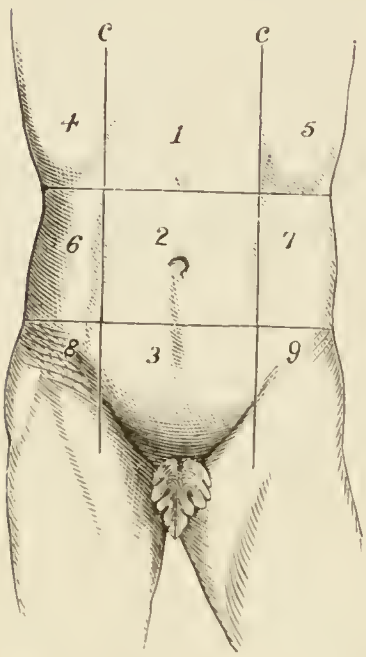


Fig. 149.—The Regions of the Abdomen.

c, c, Vertical lines; 1, epigastric region; 2, umbilical; 3, hypogastric; 4, right hypochondriac; 5, left hypochondriac; 6, right lumbar; 7, left lumbar; 8, right iliac; 9, left iliac.

Regions of the Abdomen.—For convenience of description of the viscera, and of reference to the position of the several organs in health and disease, the cavity of the abdomen is divided into nine districts or **regions**. These are marked off by two vertical and two horizontal lines. The vertical lines run from the cartilage of the eighth rib on each side to the middle of the groin; the upper horizontal line runs round the abdomen at the level of the cartilages of the ninth ribs, and the lower one at the highest level of the haunch-bones. The three regions in the middle line of the body are named, the upper, the **epigastric**; the middle, the **umbilical**; and the lower, the **hypogastric.** The three lateral ones are named, the **right** and **left hypochondriac** (under the cartilages of the ribs), the **right** and **left lumbar**, and the **right** and **left iliac** or **inguinal.**

The viscera found in each of these regions are here arranged in tabular form:—

Right Hypochondriac.	Epigastric.	Left Hypochondriac.
Right Lobe of Liver.	Left and part of right Lobe of Liver.	Great end of Stomach.
Hepatic Flexure of Colon.	Gall-bladder.	Spleen.
Supra-renal Body.	Duodenum.	Tail of Pancreas.
Upper end of Kidney.	Stomach.	Splenic Flexure of Colon.
	Pancreas.	Supra-renal Body.
	Part of Spleen.	Upper end of Kidney.
	Part of both Kidneys and Supra-renal Bodies.	

Right Lumbar.	Umbilical.	Left Lumbar.
Ascending Colon. Lower part of Kidney. Small Intestines.	Omentum. Mesentery. Transverse Colon. Duodenum. Small Intestines. Part of both Kidneys.	Descending Colon. Lower part of Kidney. Small Intestines.
Right Iliac.	**Hypogastric.**	**Left Iliac.**
Cæcum. Vermiform Appendix. Small Intestines. Ureter.	Small Intestines (Bladder and Womb when enlarged).	Sigmoid Flexure. Small Intestines. Ureter.

Peritoneum.—The abdominal cavity is lined by a delicate serous membrane called the **peritoneum**. Not only does this form a lining for the abdominal wall in front, at the sides, above, below, and behind, it also envelops, in greater or lesser degree, all the viscera contained in the cavity, and forms folds by which they are connected with each other, or are tethered to the posterior wall. Its arrangement is, therefore, necessarily very complicated; a study of fig. 150 will enable the reader to appreciate the complexity, and may give some general notion of the purposes the membrane serves.

1, First piece of sacrum; 2, first lumbar vertebra; 3, dorsal vertebræ; 4, diaphragm; 5, liver; 6, stomach; 7, transverse colon; 8, small intestines; 9, transverse duodenum; 10, pancreas; 11, rectum; 12, vagina; 13, bladder; 14, symphysis pubis; 15, great cavity of the peritoneum; 16, lesser cavity; 17, reflection of peritoneum from diaphragm on to liver; 18, peritoneum passing from liver to stomach and forming lesser omentum; 19, great omentum; 20, meso-colon; 21, mesentery; 22, recto-vaginal pouch; 23, broad ligament; 24, superior ligament of bladder; 25, coccyx. [Leidy.]

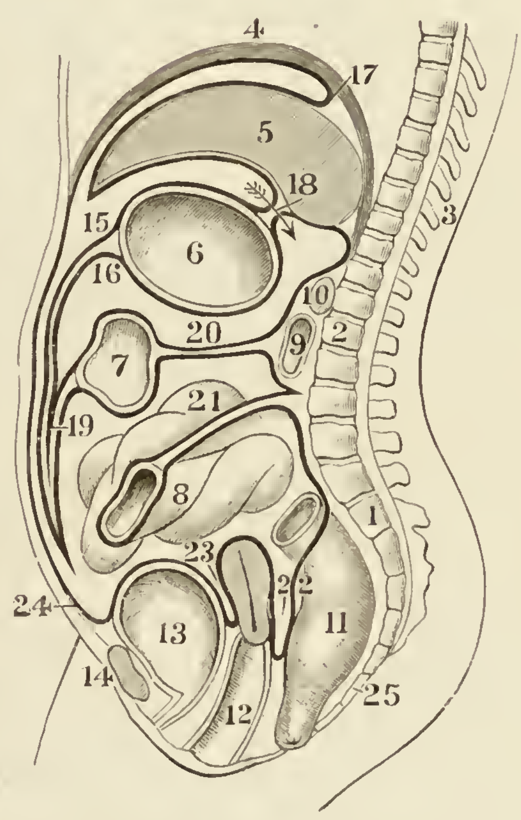


Fig. 150.—Vertical Section of the Abdomen, showing the Reflections of Peritoneum.

The folds of peritoneum receive different names according to their position and uses, being called **ligaments**, **mesenteries**, and **omenta**. The chief **peritoneal ligaments** are: (1) those

which sling up the liver to the under surface of the diaphragm; (2) a band which supports the spleen; (3) the folds covering the back, sides, and top of the urinary bladder; and (4) the layers of peritoneum clothing the womb in front and behind, and passing off from it to the pelvic wall on each side; these are called the **broad ligaments of the uterus.**

The **Mesenteries** are double folds of peritoneum connected by one edge to the intestine, and fixed by the other to the posterior wall of the abdomen; they thus serve to tether the bowel to that wall, while at the same time they allow of considerable movement of it in certain directions and within certain limits. The fold connected with the small intestine forms the **mesentery** proper, the others being named from the part of the bowel they are attached to—**meso-colon, meso-cæcum, meso-rectum, meso-sigmoid**, and the like. The mesentery is shaped like a gigantic fan, the wide border of it (which is attached to the bowel) measuring about twenty feet, and the narrow one not more than fifteen inches; it is necessarily not spread out, but thrown into folds, the arrangement of which varies as the bowels constantly move on each other. It contains between the two peritoneal layers the *mesenteric arteries* passing to the small intestine, the *veins* leaving it, the *lacteal* or *lymphatic vessels* for carrying into the blood the products of digestion (see fig. 105, p. 145), the *mesenteric lymphatic glands*, the *nerves* passing to the intestines, and a considerable quantity of fat.

The **Omenta** are so called because of the large amount of fat they contain. The **small omentum** connects the upper border of the stomach with the under surface of the liver. The **great omentum** (the *leaf*, or *caul*) hangs down from the lower border of the stomach and forms a large sheet, in most cases covering the small intestine, and extending to the lower part of the abdominal cavity; it consists in greater part of its extent of four layers of peritoneum, and is loaded with fat for the protection of the delicate bowels from the effects of external cold. The great omentum forms a component of all large and old-standing *hernias* (*ruptures*), and indeed in such

conditions may constitute the greater part of the tumour. In all *ruptures* the peritoneum is carried down with the bowel or omentum and forms the *hernial sac.*

The **Peritoneal Cavity** is a completely closed sac in the male, but in the female it is in communication with the cavity of the uterus, by means of the open end of the Fallopian tubes or oviducts. In the male a portion of the peritoneum is carried down by the testicle in its descent, but soon becomes com-

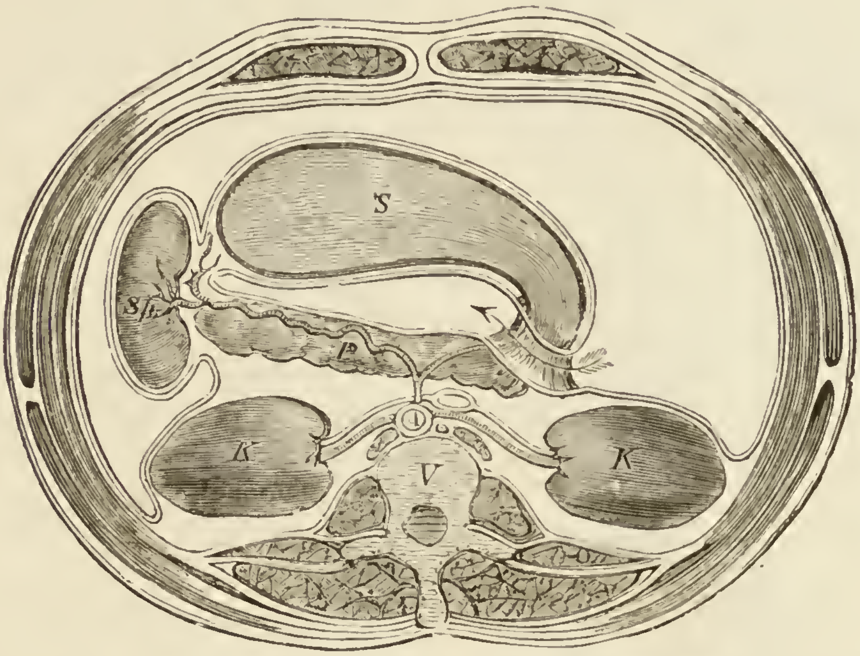


Fig. 151.—Transverse Section of the Abdomen passing through the Middle of the Stomach. The arrow passes from the greater to the lesser cavity of the peritoneum. [Wilson.]

S, Stomach; P, pancreas; Sp, spleen; K, kidney; V, vertebra; A, aorta.

pletely shut off from its connection with that lining the abdominal cavity. This portion covers the front and sides of the testicle, where it lies in the scrotum, and is called the **tunica vaginalis testis**; it forms a completely shut sac in which not unfrequently fluid accumulates, such a collection of fluid being known as a *hydrocele.*

A reference to fig. 151 will show that some of the viscera are covered by peritoneum only on their front surface, while others are completely surrounded by it; such an organ as the kidney, for instance, being only covered in front, can be removed from the body (and the operation is occasionally done) without disturbing the peritoneum, but this is impossible with the stomach or the small bowel.

The peritoneum, when in health, secretes only sufficient fluid to keep its surface lubricated, so that the bowels may move freely and smoothly on each other and on the other viscera. In disease the fluid increases in amount, and the abdominal cavity may become greatly distended; this condition is known as *ascites* or *dropsy*.

The Alimentary Canal.—The **Alimentary Canal** or **food passage** is a tube formed of mucous membrane and muscular fibre, and extends from the mouth to the anus. In the different parts of its course it receives different names, these being, in order from above downwards as follows:—

Mouth.
Pharynx or food-bag.
Œsophagus or gullet.
Stomach.
Small Bowel, { Duodenum. Jejunum. Ileum.
Great Bowel, { Cæcum. Colon. Rectum.

The **Mouth** is a cavity formed by the lips in front, cheeks at the sides, tongue below, and palate above. The **palate** or roof of the mouth is, in the front part, formed by bone covered by mucous membrane (this being called the **hard palate**), and behind by a soft curtain formed of muscles and mucous membrane (the **soft palate**), hanging in an arched manner from the back of the former. The bones contributing to the formation of the hard palate are the palate processes of the two palate bones and the two upper jaws. The **soft palate** has, dependent from the middle of its free edge, a little lobe, the **uvula**, containing in its interior a small muscle by which it can be shortened. The hard and soft palate form the roof of the mouth and the floor of the nose. In the congenital condition known as *cleft palate* this septum is incomplete, a slit being left through which the nose and mouth communicate; this accounts for the nasal speech of such patients. The opening

between the soft palate and the tongue leading into the pharynx is called the **fauces**, or **isthmus of the fauces**. Passing down on each side are two folds of mucous membrane, the **pillars of the fauces**; they originate in common from the edge of the soft palate, but separate as they descend, the one passing to the tongue, the other to the pharynx. In the space formed by the divergence of the pillars of the fauces on each side is the **tonsil**, formed mainly of lymphoid tissue, and covered by a mucous membrane in which are large mucous cavities or crypts.

The mucous membrane of the soft and hard palate is endowed with the sense of taste; it has in its structure many small glands for the secretion of mucus. Similar glands are found in the mucous membrane lining the cheeks and lips (labial glands).

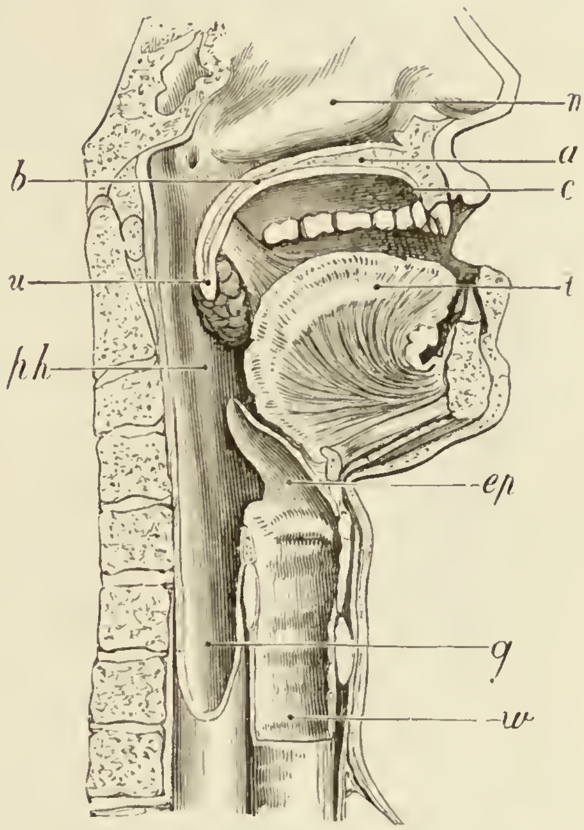


Fig. 152.—Section showing Mouth and Nasal Cavities, Gullet, Windpipe, &c.

t, tongue; *ph*, pharynx; *ep*, epiglottis; *g*, gullet; *w*, windpipe; *n*, one of the turbinated bones of the nose; *a*, hard palate; *b*, soft palate; *c*, roof of mouth; *u*, uvula.

The **Teeth** are imbedded in sockets in the alveolar processes of the upper and lower jaw. There are two sets of teeth or *successions* as they are called, the one being cut (or erupted) in the first two years of life, and the second from the sixth to the twentieth year. The former are known as the **milk teeth** or **temporary teeth**, the latter as the **permanent teeth**. Each tooth consists of a **crown**, projecting above the gum, and one or more **fangs** or **roots**, buried in the sockets in the jaw; the constricted part marking the union of these parts being known as the **neck**. They differ in form from one another, and have different names according to their shape and use. Thus, in the adult, the four central teeth have sharp, chisel-like edges

to the crowns, and hence are called **incisors**. Next to these on each side is a pointed tooth with a very long fang, which, from its being especially prominent and large in the dog and his congeners, is called the **canine** or **dog tooth**. Then follow on each side two teeth called **bicuspid** from the fact that their crowns are marked by two points or cusps; they often have double fangs. Lastly, there are on each side three **molar** teeth or **grinders**, with four or five points to the surface of each crown; the lower teeth have two fangs, and the upper three. The last molar is called the **wisdom tooth**, because not usually cut till the person has reached "years of discretion". It is smaller than the others, is very firmly wedged in, and has usually only two fangs both in the upper and lower jaw.

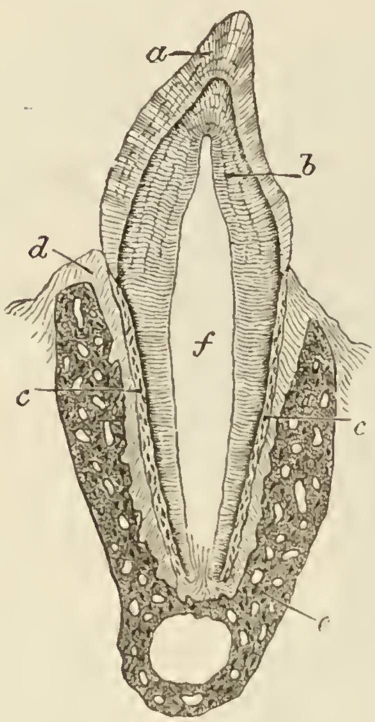


Fig. 153.—Structure of Tooth (magnified).

a, enamel; *b*, dentine; *c*, cement; *d*, gum; *e*, alveolar process of jaw; *f*, pulp cavity.

The **Temporary teeth** are only twenty in number, there being no bicuspids and only two molars on each side, above, and below. The **permanent teeth** are thirty-two in number, sixteen in each jaw. The following table shows the position of the teeth, relative to each other, in each set, and the relation of those of the temporary to those of the permanent series:—

		Mo.	Bi.	Ca.	In.	In.	Ca.	Bi.	Mo.		
Temporary teeth	Upper	2		1	2	2	1		2	=10	=20
	Lower	2		1	2	2	1		2	=10	
Permanent teeth	Upper	3	2	1	2	2	1	2	3	=16	=32
	Lower	3	2	1	2	2	1	2	3	=16	

The upright line indicates the middle of the jaw.

The **temporary teeth** usually appear at the following dates:—

	Mo.	Ca.	In.
Months	24, 12.	18.	9, 7.

The first to be cut are generally the central incisors of the lower jaw, then the corresponding teeth of the upper, next the lateral incisors of the upper and then the lateral of the lower. The period and order of eruption is, however, liable to great variation, and teething is especially late in children affected with rickets.

The **Permanent teeth** are cut at the following dates in most instances:—

Molars, first,	6	years.
Incisors,	7 to 8	,,
Canines,	11 to 12	,,
Bicuspids,	9 to 10	,,
Molars, second,	12 to 13	,,
,, third,	17 to 25	,,

The first permanent tooth is often spoken of as the "six-year-old molar"; it is the first to come, and is very commonly the first to show signs of decay.

Structure of Teeth.—Fig. 153 represents a vertical section of a tooth carried through its centre. The interior will be observed to be hollowed out into a cavity—the **pulp cavity**, which is filled up by the **dental pulp**, a delicate connective tissue supporting blood-vessels and nerve-endings, the latter entering by means of a small opening at the apex of the fang. The bulk of the tooth is formed by **dentine** or **tooth-ivory** traversed by fine branching tubes, the **dentinal tubes**, occupied by threads of protoplasm continuous with that of the pulp. Covering the fang is a substance closely resembling bone named **cement** or **crusta petrosa**; it only differs from true bone in having no Haversian canals. The crown of the tooth is formed by the **enamel**, a tissue much whiter, harder, and more brittle than the other two; it is formed of closely-set prisms of dense material composed mainly of earthy salts and only $3\frac{1}{2}$ per cent of animal matter. When the teeth are first cut the enamel is covered by a delicate membrane, the **cuticle of the enamel**, or **skin of the teeth**; this is soon worn away by attrition. The teeth are held in their sockets by means of a fibrous membrane, the **periodontal membrane**, lying between the wall of the cavity and the cement of the fang.

The **Tongue** has been already described (p. 188).

The **Salivary glands**, for the secretion of the saliva or spittle, are three in number on each side—the *parotid*, *submaxillary*, and *sublingual.*

The **Parotid gland** is placed at the side of the face, in front of, and a little below the ear. Its deep portion passes behind the jaw into the glenoid fossa of the temporal bone; its superficial part overlaps the jaw, and extends for about an inch in front of the ear. From its anterior edge there issues a duct called **Stenson's duct**, which serves to carry the secretion of the gland into the mouth. The duct passes through the cheek, and opens opposite the second molar tooth of the upper jaw. Its course may be indicated by a line drawn from the middle of the lobule of the ear to the middle of the upper lip. The gland is covered by a strong and thick layer of fascia attached above to the zygoma, hence its presence on the side of the face is not distinguishable unless when it is inflamed. In the affection known as "mumps" this gland is swollen, and the pain then experienced results from the inflamed tissue being thus firmly bound down.

Fig. 154.—The Salivary Glands.

P P', Parotid; *s m*, submaxillary. *d* is placed below the duct of the parotid.

The parotid gland is traversed by the branches of the facial nerve, and by the external carotid artery, the temporo-maxillary vein, and their branches; the internal carotid artery lies on its inner surface.

The **Submaxillary gland** is placed (as its name indicates) beneath the jaw, near to the angle of that bone. It lies for the most part below the mylo-hyoid muscle, but a small portion lies above that muscle. Its duct, called **Wharton's duct**, opens on to a little papilla in the mucous membrane of the floor of

the mouth, close to the frenum of the tongue. The gland has the facial artery imbedded in its substance.

The **Sublingual gland** lies in the curve of the body of the lower jaw, above the mylo-hyoid muscle, and immediately beneath the mucous membrane lining the floor of the mouth. Its ducts are numerous and small; some of them open into Wharton's duct and others by small openings around the papilla on which that duct terminates.

The **Salivary glands** are all of the racemose variety, a description of which has been given on a previous page (p. 30). They are copiously supplied with blood-vessels derived from branches of the external carotid artery, and by nerve twigs from the fifth cranial nerve, the cervical plexus, and the sympathetic. The nerves regulate the activity of the gland and affect the secretion of saliva.

The Pharynx.—The **pharynx** or **food-bag** is the upper end of the alimentary canal. It is $4\frac{1}{2}$ inches in length, and is attached above to the base of the skull, and terminates below in the commencement of the gullet or œsophagus, opposite the upper border of the body of the sixth cervical vertebra. It passes up behind the nasal cavities, and terminates above in a cul-de-sac at the base of the skull.

The pharynx is widest opposite the hyoid bone, and narrowest at its termination. There are seven openings into it, namely the following:—

Nose,—Two Posterior Nares.
Mouth,—Fauces.
Eustachian Tubes (2).
Larynx or Voice-box.
Œsophagus or Gullet.

The **Posterior Nares** are the openings of communication between the nasal cavities and the pharynx. Each measures about three-quarters of an inch in height by about half an inch in width, and it is necessary to bear in mind these dimensions in plugging the posterior nares to check bleeding from the nose.

The **Fauces** have been already described (p. 221).

The **Eustachian Tubes** are the communications between the pharynx and the cavity of the middle ear. Their expanded ends lie behind and a little below the extremities of the lower turbinated bones. They are covered by a thick mucous membrane, and at their entrance into the pharynx there is a little depression or fossa. A properly-shaped catheter introduced along the floor of the nose can easily be made to enter the cavity of the Eustachian tube, and in this way air can be forced into the tympanic cavity, or the canal can be dilated when it has undergone contraction.

The other openings into the pharynx do not call for special description here.

The pharynx is composed of the three constrictor muscles described on a previous page (p. 84), of fibrous bands, and a layer of strong fascia, and is lined by a thick mucous membrane in which there are numerous racemose glands, and masses of lymphoid tissue. The latter tissue undergoes considerable increase in disease, and forms one of the most troublesome and intractable forms of sore throat; the masses thus formed being now generally known as *adenoid vegetations.* The pharynx has a free supply of blood-vessels and nerves, the latter being derived from the vagus, glosso-pharyngeal and sympathetic nerves.

The Gullet or Œsophagus.—This is a musculo-membranous tube extending from the pharynx to the stomach, and serving for the conveyance of food. It is not by any means straight, but has an antero-posterior bend at the upper part of the chest, corresponding with the curve of the vertebral column, and a slight deviation to the left in the lower part of the neck, and again, just as it passes through the diaphragm to enter the stomach. It is about nine or ten inches in length, commencing at the level of the body of the sixth cervical vertebra, and terminating at that of the tenth dorsal.

In its course the gullet lies first behind the trachea, then descends behind the arch of the aorta in the chest, runs behind the left bronchus and in front of the thoracic aorta to the diaphragm; piercing this it ends in the upper part of the stomach.

When food is not passing the canal is closed, and the lining membrane is thrown into longitudinal folds.

In **structure** the gullet is formed externally of circular and longitudinal muscular fibres, these being of the striped variety in the upper part of the tube but unstriped in the lower. Next to the muscular coat is a loose submucous coat formed of areolar and elastic tissue. Within this is a thick and firm mucous membrane, lining the canal. It is studded over by a number of fine papillæ, is covered by a stratified epithelium, and has opening on to its surface numerous racemose glands.

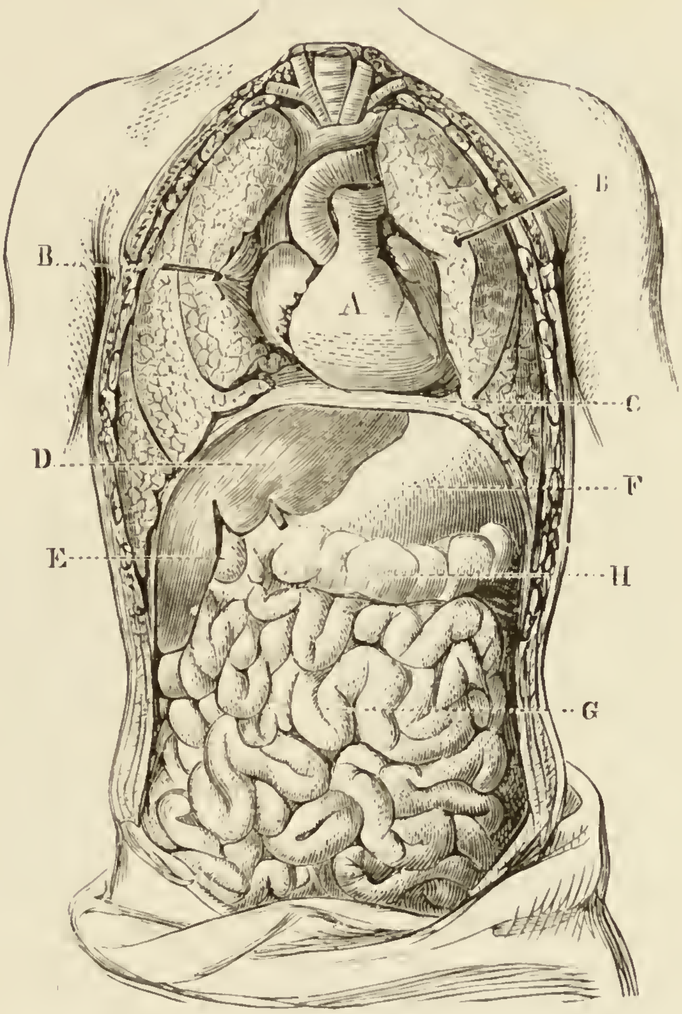


Fig. 155.—The Contents of Chest and Abdomen shown in their Positions.

A, heart; B, B. lungs; C, diaphragm; D, liver; E, gall-bladder; F, stomach; G, coils of small intestine; H. transverse part of colon.

The Stomach.—The **stomach** is an expansion of the alimentary canal, placed in the upper part of the abdominal cavity. It is mainly situated in the left hypochondriac region, but also occupies the epigastric region. The hypochondriac part forms three-fourths of the organ, and its long axis is vertical in the erect posture of the body; the epigastric part forms the remaining fourth, has its axis transversely directed, and lies about three fingers' breadth below the ensiform cartilage. The stomach is cone-shaped, with its great end directed upwards and to the right and its lesser end downwards and to the left. It is divided into a middle part or **body**, a greater or **splenic end**

(*fundus*), a lesser or **pyloric end**; it has a lesser curvature above, a greater curvature below; an anterior and a posterior surface; a **cardiac orifice** and a **pyloric orifice**. The **fundus** is the most expanded part, and has the spleen lying in contact with it. The **pylorus** is an annular contraction where the stomach ends and the small bowel begins. It is marked by an increase of the circular muscular fibres forming a circular valve or sphincter (*pyloric valve*). "It would be pierced when the stomach is empty by a needle passing through the abdominal wall five centimetres below the junction of the seventh right costal cartilage with the sternum" (*A. M'Alister*).

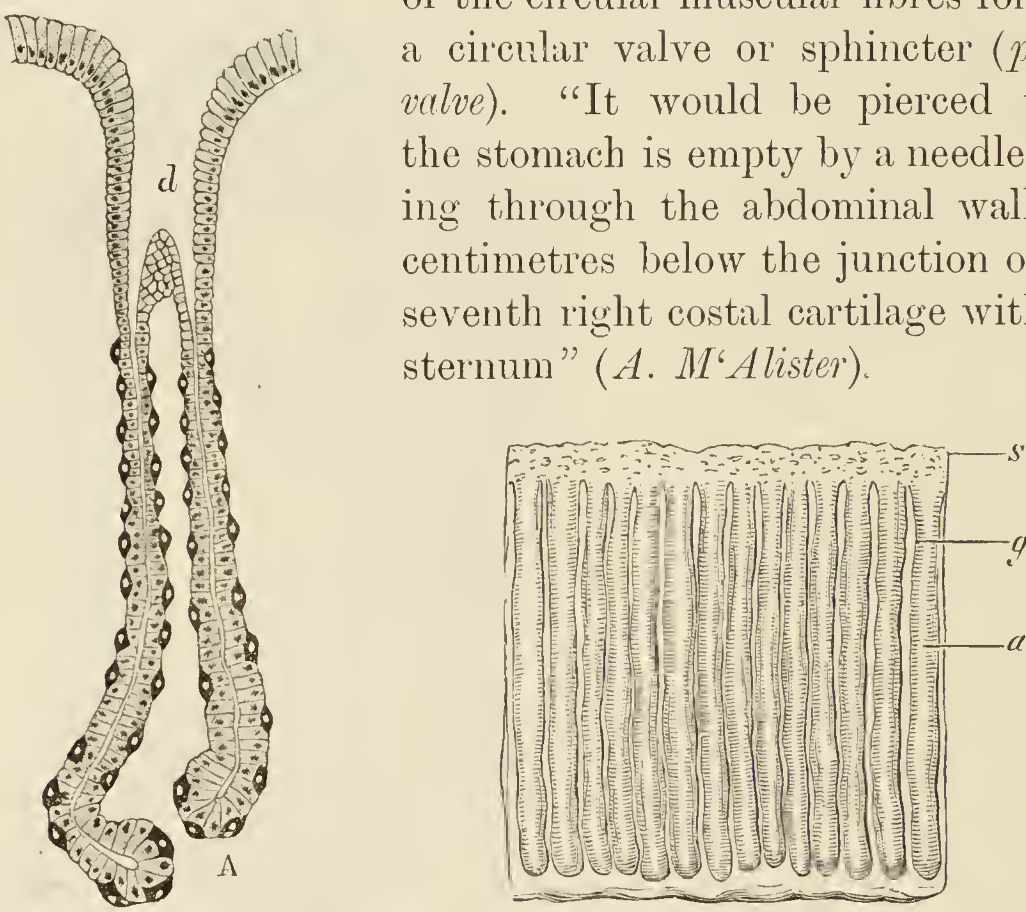


Fig. 156.—The Mucous Membrane of the Stomach, highly magnified.

s points to the surface, *g* to one of the tubular glands, of which *a* indicates the central canal. A is a much more highly magnified view of one gland, which is represented as giving off branches. It shows the columnar epithelium of the surface dipping down into the duct *d* of the gland, from which two tubes branch off. Each tube is lined with columnar cells, and there is a minute central passage. Here and there are seen other special cells, called parietal cells, which are supposed to produce the acid of the gastric juice.

The upper or lesser curvature of the stomach is connected to the liver by means of the lesser omentum, and from the lower or greater curvature the great omentum depends. When the stomach is empty only a small portion is in contact with the anterior abdominal wall, but when much distended a very large area is presented to the wall.

The stomach is held in place by its connection with the gullet, and through its means with the diaphragm. By its upper

border it is loosely connected with the liver by the lesser omentum; its lower border is held in connection with the large bowel by means of the great omentum. The pyloric end is fixed by the small bowel being attached to the posterior abdominal wall.

When moderately full it is capable of holding from five to ten pints of fluid.

Structure.—The stomach is covered externally by the **serous membrane** of the abdomen—the peritoneum. This entirely envelops it, excepting where the vessels and nerves enter along its upper and lower border, and a small portion at the back. Next to this coat are three layers of **unstriped muscular fibre**; the outer, arranged longitudinally, and best developed along the two curvatures; the middle, circular and best seen towards the pyloric end; and the inner fibres, oblique and restricted to the great end. The next coat is composed of loose **areolar tissue**—the **submucous tissue**—in which the vessels and nerves break up into branches, and where the chief lymphatic vessels are distributed. Lastly, there is the **mucous coat**, the most important of them all because it contains the glands for the secretion of the gastric juice. The mucous membrane is redder and softer than that of the gullet. When the stomach is empty it is thrown into longitudinal folds or **rugæ**, but these are obliterated when it is distended. It is a comparatively thick membrane, the thickness resulting from the large number of glands contained in its substance. These are of two kinds,—**simple** or **mucous glands** similar to those found in the gullet and elsewhere, and **peptic** or **gastric glands**, for the secretion of the gastric juice. The simple or mucous glands are lined by a single layer of columnar epithelial cells, similar to those covering the surface of the mucous membrane. The peptic glands are lined in their upper part (throat or neck) by the same kind of cells, but in the lower or deeper part the cells are spheroidal, have a large and distinct nucleus, and their protoplasm is granular. These deeper cells are called the **parietal** or **oxyntic cells**.

Of the two openings into the stomach the upper is called

cardiac (because placed near the region of the heart), is directed upwards, has no special valvular arrangement, and is so dilatable that large bodies are often passed through it. The other, or **pyloric**, opening is at the outlet from the stomach; it is guarded by a circular band of fibres—the pyloric valve—is

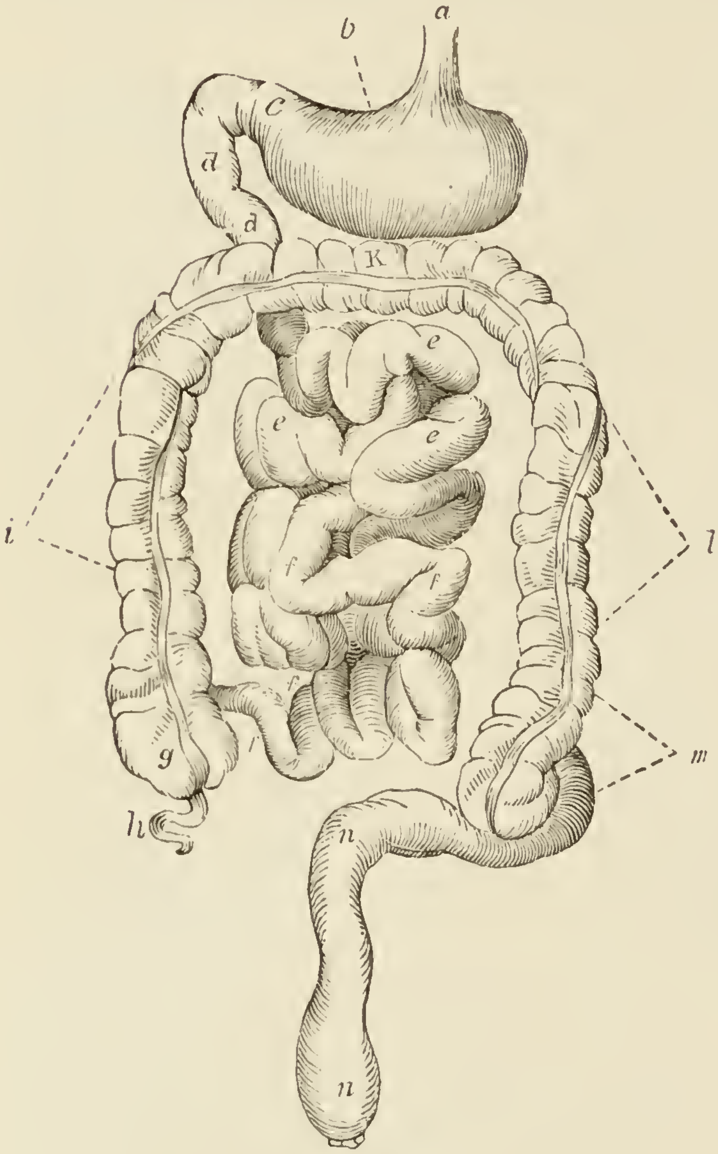


Fig. 157.—The Alimentary Cana

a, The gullet, or œsophagus.
b, The stomach.
c, The pylorus, the small end of the stomach where it opens into the first part of the small intestine.
d d, The duodenum or commencement of the small intestine.
e e e, The second part of the small intestine, called the jejunum.
f f f f, The third and terminal portion of the small intestine, termed the ileum.
g, The cæcum.
h, A round wormlike process of the cæcum, which is termed the vermiform appendix.
i, The first portion of the large intestine, called the ascending colon.
K, The transverse colon.
l, The descending colon.
m, The sigmoid flexure of the colon.
n, The rectum.

directed backwards and slightly downwards, and is not capable of much dilatation.

The stomach obtains a very free blood supply from the branches of the splenic, gastric, and hepatic arteries; its nerves come from the vagus and sympathetic nerves.

Small Intestine.—The small intestine is continuous with the pyloric end of the stomach; it is about twenty to twenty-five feet in length, and terminates by opening into the large bowel in the right iliac region. At its commencement its

cavity is separated from that of the stomach by a projection due to the thick annular band of muscular fibres forming the pyloric valve. In life this is capable of completely closing the lower outlet of the stomach, but is relaxed from time to time during the process of digestion to allow the contents of the stomach to pass into the small intestine.

The small bowel is divided into three parts, the *duodenum*, *jejunum*, and *ileum*.

The **Duodenum** is about eight to ten inches in length. It is the most fixed part of the small bowel, being in the lower two-thirds of its extent covered only in front by peritoneum, and consequently bound down by it to the posterior abdominal wall. The duodenum forms a horseshoe curve around the right side of the head of the pancreas, and has entering into it, about its middle, the *common bile duct* (carrying the bile from the liver and gall-bladder) and the *duct of the pancreas* or *sweet-bread*.

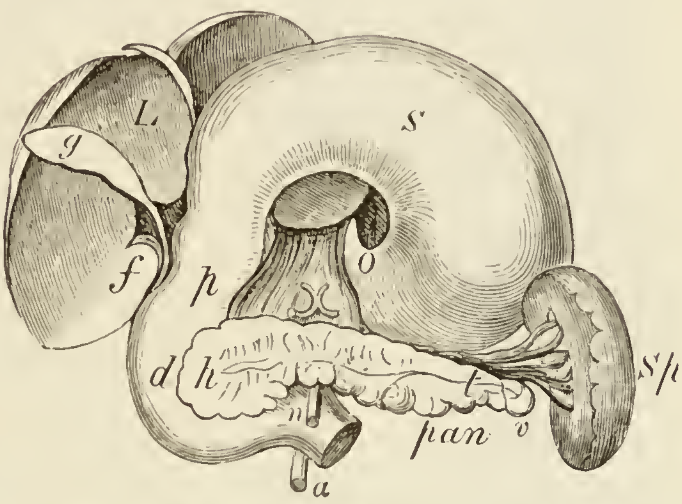


Fig. 158.—Relations of the Stomach to the Liver, Pancreas, and Spleen.

S, Stomach; *p*, pylorus; *o*, œsophagus ending in the stomach; *d*, duodenum; *L*, liver; *g*, gall-bladder; *h*, head of the pancreas; *t*, tail of the pancreas; *f* is placed beside the union of the duct from the liver and that from the gall-bladder; *Sp*, spleen; *v*, the part where the blood-vessels are connected to the spleen; *n* and *a*, blood-vessels.

The **Jejunum** forms two-fifths of the small intestine, and is generally found empty after death; hence its name, from Lat. *jejunus*, empty. It has very thick walls, is attached throughout its entire extent to the posterior wall of the abdomen by the double fold of peritoneum, already described as the mesentery, and is situated chiefly in the umbilical and iliac regions.

The **Ileum** (Gk. *eileō*, I twist) forms the remaining three-fifths of the small bowel. It is thinner and paler than the jejunum, and lies for the most part in the umbilical and hypo-

gastric regions. It terminates in the right iliac region, where it opens into the large bowel.

Although the small bowel is thus divided, for the convenience of description, into three parts, they are continuous, and there is no mark to indicate where the one ends and the other begins.

Structure of the Small Intestine.—Like the stomach the small bowel has four coats, the *serous*, *muscular*, *submucous*, and *mucous*.

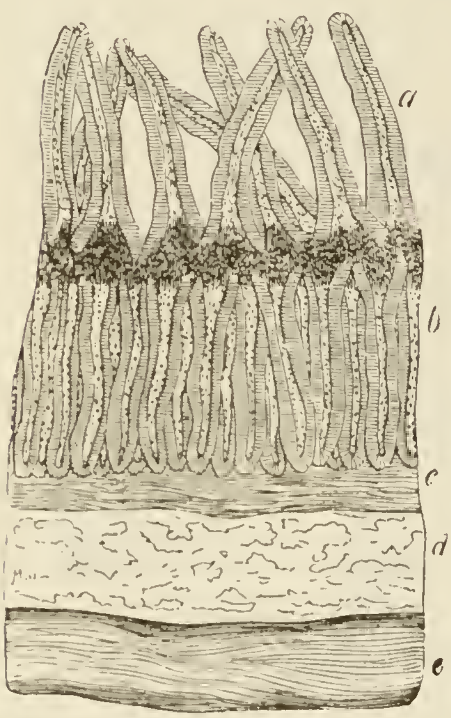


Fig. 159.—Microscopical Structure of the Small Intestine.

a, Villi; *b*, glands of Lieberkühn; *c*, submucous layer; *d*, inner muscular layer; *e*, outer muscular layer.

The **Serous coat**, formed by the peritoneum, completely surrounds the bowel, excepting in the lower two-thirds of the duodenum, where it only covers the front surface.

The **Muscular coat** is composed of two layers of unstriped muscular fibres, those of the outer layer being longitudinal and those of the inner circular.

The **Submucous coat** is composed of areolar and elastic tissue and forms a loose layer in which the blood-vessels, nerves, and lymphatics are distributed.

The **Mucous membrane** of the small bowel is thinner than that of the stomach; it is smooth in the upper part of the duodenum (above the opening of the biliary and pancreatic ducts), but below is raised into crescentic folds, the **valvulæ conniventes** or **valves of Kerkring**. These folds are continued through the jejunum (where they are especially large and well-developed) into the ileum; here they gradually get smaller and less numerous, till they altogether disappear at the lower third of the ileum, below which the mucous membrane is again smooth. The valvulæ conniventes differ from the rugæ of the stomach in not being obliterated when the wall of the bowel is put on the stretch. They are supposed to serve two purposes, namely, to increase the extent of the surface of the

bowel, and secondly, to delay mechanically the progress of the intestinal flow.

The mucous membrane of the small bowel presents throughout a velvety appearance, and if a small portion of it be floated in water, it is seen to be studded over by a great multitude of minute projections, not unlike the pile of velvet. These projections are called **villi**. When a villus is examined under the microscope, it is found to be composed of the different structures represented in fig. 160. The mass of the villus is formed of adenoid tissue, in which is a fine capillary plexus, derived from a small artery and terminating in a small vein. In the centre of the villus is a large lymphatic vessel ending in a blind extremity; this is the beginning of a **lacteal**, so called because during digestion it carries a milk fluid (Lat. *lac*, milk) resulting from the digestion of the food. The surface of the projection is covered by a single layer of columnar epithelial cells, in which, here and there, may be seen one distended with mucus and called a "*goblet-cell*". Buried in the deeper part of the mucous membrane are a large number of simple follicular glands, the **glands of Lieberkühn**, lined with columnar cells, and opening at the bases of the villi. Throughout its entire extent the mucous membrane of the small bowel is covered by a single layer of columnar epithelial cells.

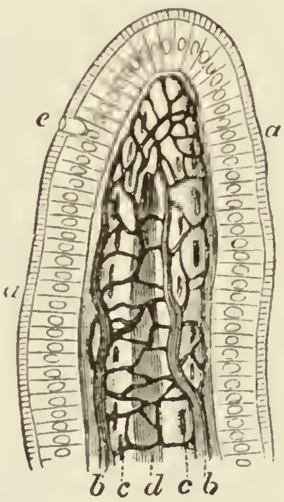


Fig. 160.—A Villus of the Small Intestine, largely magnified.

a, columnar cells; *e*, goblet cell, modified columnar; *b*, *c*, blood-vessels; *d*, a lacteal.

In the upper part of the duodenum small racemose glands are found. They are placed in the submucous layer, but their ducts open on to the surface of the mucous membrane. They are known as **Brunner's glands** or the **duodenal glands**.

Imbedded in the mucous membrane there are also little masses of **adenoid** or **lymphoid tissue**, which were at one time mistaken for glands. Many of these are scattered broadcast throughout the interior of the bowel without order or arrangement; they are spoken of as the **solitary glands**. Others are

aggregated to form oval patches known as **Peyer's glands** or **Peyer's patches.** These always run in the opposite direction to the valvulæ conniventes (namely, along the bowel instead of across it). They are more numerous towards the edge of the bowel which is free than along that attached to the mesentery, and they are especially numerous and large in the lower part of the ileum, near its entrance into the large bowel. Peyer's patches are very prone to become inflamed and to ulcerate during the course of enteric (typhoid) fever.

The small bowel has a very free supply of blood from the branches of the superior mesenteric artery; its nerve twigs are derived from the sympathetic, and form fine plexuses in the muscular coat and beneath the mucous membrane.

Large Intestine.—The large bowel is about five or six feet in length; it is sacculated, is thicker than the small bowel, and tapers gradually from its commencement to near its termination. It commences in a large pouch-like dilatation, the **cæcum**, placed in the right iliac fossa, passes up in front of the right kidney (**ascending colon**) to the under surface of the liver, then crosses beneath the stomach to the spleen (**transverse colon**); bends downwards, and descends in front of the left kidney (**descending colon**). On reaching the left iliac fossa it becomes much convoluted, forming the **sigmoid flexure**; then enters the pelvis, becoming the **rectum**, and terminates at the **anus**.

The large bowel is much more fixed than the small, from which it is always distinguishable by the following characters:—Firstly, its position; the large bowel is placed at the outer part of the abdominal cavity, the small bowel in the centre. Secondly, the longitudinal muscular coat of the large bowel is gathered into three prominent bands, that of the small one is evenly distributed over the whole calibre; as a consequence, the smaller intestine is evenly tubular, the large is sacculated. Thirdly, the large bowel has on its lower edge numerous little fatty pellets contained in peritoneal pouches (*appendices epiploicæ*): these are absent from the small bowel. Fourthly, the mucous membrane of the small intestine is throughout covered

by villi, while these are entirely absent from that of the large bowel.

The **Cæcum** forms the commencement of the large bowel, and is situated in the right iliac fossa. It is a blind pouch or cul-de-sac about $2\frac{1}{2}$ inches in length, continuous above with the ascending colon, and having attached to it below a small tail-like projection, the **vermiform appendix**. The ileum enters the colon obliquely, the edges of the opening forming well-marked folds projecting into the interior of the large bowel. These are so arranged that when there is distention of the colon they are pressed together and nearly close the opening, preventing in this way the contents of the large bowel from passing back into the small. These folds form the **ileo-cæcal valve**, and form a mechanical arrangement which is effective after death as well as during life, differing in this respect from the pyloric valve, which acts only during life.

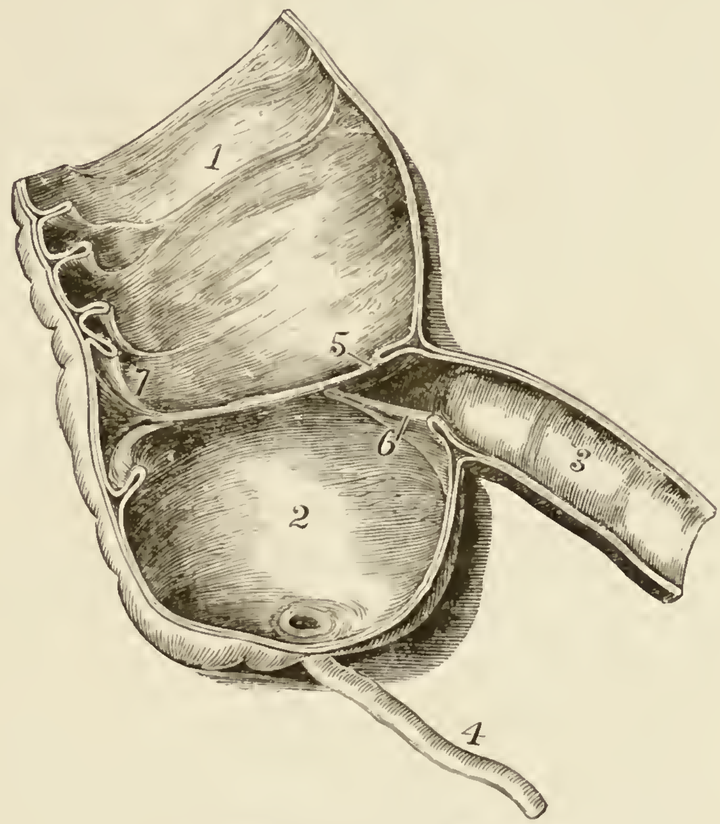


Fig. 161.—Cæcum and Ileo-cæcal Valve.

1, Ascending colon; 2, cæcum; 3, ileum; 4, vermiform appendix; 5 and 6, folds forming ileo-cæcal valve. [Wilson, after Henle.]

Structure of the Large Intestine.—The large intestine has the same coats as the small, but certain differences between them require to be noted. The **serous coat** completely surrounds the cæcum, vermiform appendix, transverse colon, sigmoid flexure, and upper part of the rectum, but only covers the ascending and descending colon in front, while the lower part of the rectum has no peritoneal covering. The

muscular coat deviates considerably from the arrangement found in the small intestine, the longitudinal fibres being gathered into three bands, and the circular fibres being thickest in the hollows between the saccules so formed. The sacculation of the large bowel is supposed to be designed for delaying the flow of the intestinal contents, thus allowing time for the absorption of fluid to take place. In the lower part of the rectum the longitudinal fibres are spread out over the whole tube, so that it ceases to be sacculated, and the circular fibres are much increased in number, and aggregated to form the *internal sphincter* of the anus. Outside the anus is a strong circular band of striped muscle, the *external sphincter.*

The **mucous membrane** of the large intestine is totally devoid of villi and of valvulæ conniventes. It has a large number of follicles, similar to those of the small intestine (**Lieberkühn's follicles**), and there are numerous scattered masses of lymphoid tissue forming the so-called **solitary glands.**

The blood-vessels and nerves of the large bowel are very numerous, and are derived from the same sources as those of the small.

The Liver.—The **liver** is the largest gland in the body, weighing from three to four pounds, and measuring in its length about twelve inches, in width six to seven inches, and at its greatest thickness about three and a half inches. It is situated in the right hypochondriac and epigastric regions, immediately beneath the diaphragm. Its lower border corresponds as near as possible to the arch formed by the lower costal cartilages and last ribs. The under surface of the liver is in contact with the stomach, duodenum, colon, right kidney, and right supra-renal body.

The liver is held in its place by five **ligaments**; four of these, formed by double folds of peritoneum, connect it with the diaphragm; the fifth (**round ligament**) runs from the umbilicus (navel) to the fissure, which separates the right and left lobe, and is the remains of the blood-vessel, which in the fœtus carried the blood from the after-birth to the child.

The liver is divided into two very unequal portions, called the **right** and **left lobes**, by a vertical fissure, the **longitudinal fissure**. The right lobe is from four to six times the size of the left, and a portion of it is subdivided into a number of smaller lobes, of which the most important is a prominent square one near the posterior border, called the **Spigelian lobe**. There are also several fissures on the under surface of the right lobe. One of these near the centre is called the **transverse** or **portal fissure**; it gives passage to the portal vein, hepatic artery, hepatic duct (conveying the bile from the liver), nerves, and lymphatics. Another fissure, to the right side of the Spigelian lobe, receives the inferior vena cava, and a shallow groove towards the front of the liver lodges the gall-bladder.

From the under surface of the liver the lesser omentum passes to the upper border of the stomach.

Position of the Liver in relation to the Abdominal and Thoracic Wall.—The upper convex surface of the liver reaches as high as the level of the articulation of the fifth rib on the right side with the breast-bone; the lower border corresponds pretty accurately with the cartilages of the sixth, seventh, eighth, and ninth ribs on the right side. The left lobe extends to about an inch to the left of the middle line, and lies against the anterior wall of the abdomen, its lower border being indicated by a line drawn from the ninth right to the eighth left costal cartilage. The gall-bladder has its end at the outer border of the rectus muscle, under the ninth right costal cartilage.

The **Portal vein** enters the liver at the transverse or portal fissure, and carries the blood used for the formation of the bile. The **Hepatic artery** enters at the same fissure, and furnishes blood for maintaining and renewing the tissues of the organ itself. The return blood from both these sources is carried away from the liver by the **hepatic veins**, and these empty into the inferior vena cava, where it lies in the fissure beside the Spigelian lobe.

The whole exterior of the liver is covered by peritoneum,

excepting a small portion of the upper surface and posterior border. Beneath this is a coat of fibrous tissue, forming the **capsule** of the liver, and so intimately connected with its structure as to be absolutely inseparable. The liver is formed by the aggregation of an immense number of **lobules**, each of which is a miniature organ, so that, if we study one of these, we have all the knowledge essential to understand the whole organ. Each lobule is oval or hexagonal in cross section, and is composed of fibrous tissue, supporting a mass of nucleated protoplasmic cells.

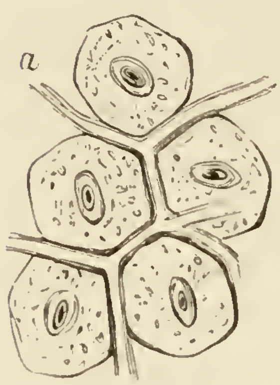


Fig. 162.—Cells of the Liver (very much magnified) with channels (*a*) for the bile between.

On the outside of each lobule a capillary plexus (**interlobular plexus**) distributes the blood derived from the portal vein. These vessels penetrate the lobule and ramify throughout its interior, forming a **lobular venous plexus**, and supplying to the liver cells the material for the formation of bile. A vessel placed in the centre of the lobule, and called the **intralobular vein**, gathers up the blood from the lobular plexus and carries it into the hepatic vein, by means of which it at length reaches the inferior vena cava. Between the cells are very fine channels for the bile (fig. 162), the **biliary ducts,** and these unite to form a plexus, the branches of which get larger as they near the surface of the lobule. Between the lobules they form another plexus, and from this the larger ducts proceed, which at length terminate in two channels of considerable size, one for each lobe of the liver. These have no sooner emerged at the transverse fissure than they unite to form the **hepatic duct,** and this in turn is joined by the **duct from the gall-bladder,** the two together constituting the **common bile duct,** which, as we have already seen, terminates in the duodenum.

The **Biliary cells** are composed of very active protoplasm. They have a granular appearance, possess a distinct nucleus and nucleolus, and frequently contain oil vesicles. They take the constituents of the bile from the portal blood, and, after elaborating that fluid, empty it into the fine biliary ducts

surrounding them. The bile is thus formed from venous blood derived from the stomach and intestines, and this circumstance accounts for the large size of the portal vein where it enters the liver, and the comparatively small artery (the hepatic) going to that organ. The latter vessel supplies blood for the nourishment of the liver substance, and only indirectly contributes a small amount for the formation of bile.

Gall-bladder.—The **gall-bladder** is a pear-shaped sac, situated on the under surface of the right lobe of the liver, and serving as a reservoir for the bile, in which it is stored when not required in the intestine. The necessity for such a receptacle is apparent, if we bear in mind that the secretion of bile goes on continuously, while it is only intermittently that it is required, namely, during digestion.

The gall-bladder has a large end directed downwards and outwards, and projecting a little beyond the edge of the liver, opposite the ninth costal cartilage of the right side, and a narrow end terminating in a duct, the **cystic duct**, which joins with the hepatic duct to form the common bile duct.

It is covered by peritoneum on its under surface, and by its upper is connected with the liver by areolar tissue. It has a muscular coat, formed of longitudinal and circular unstriped muscular fibres and fibrous tissue, and is lined by a thick mucous membrane, which is everywhere raised into folds or rugæ, some of these near the commencement of the duct forming a beautiful spiral valve to regulate the outflow of the bile.

The Pancreas.—The **pancreas** or **sweet-bread** is a long, flattened gland, resembling closely in structure the salivary glands. It lies across the vertebral column behind the stomach; measures about six inches in length, and weighs from three to four ounces. Its right extremity is much the widest part, and is called the **head**; it is embraced in the horse-shoe curve of the duodenum, and is intimately connected with that part of the small intestine. The other end is very narrow, and is called the **tail**; it lies in contact with the spleen. Near the middle of the gland runs a **duct**, receiving the small ducts from all the lobules, and terminating by opening into the back of

the duodenum, either alone or after uniting with the common bile duct.

In **structure** the pancreas is made up of lobules, each of which consists of a number of acini or recesses, lined by columnar epithelial cells.

The Spleen.—The **spleen** is an oval, flattened organ, of a dark, bluish-red colour, situated in the left hypochondriac region, and corresponding to the ninth, tenth, and eleventh ribs in the axillary line. It varies greatly in size and weight, even in health, but on an average is about five inches in length and weighs six ounces. It is of very soft texture and is easily torn. The outer surface is convex, the inner concave, and marked by a depression for the entrance of the vessels and nerves. By its inner surface it lies against and is connected with the great end of the stomach and tail of the pancreas; its upper end rests on the diaphragm, and its lower on the colon; its posterior surface touches the left kidney and supra-renal body. Sometimes there are several additional spleens, most of them not larger than marbles.

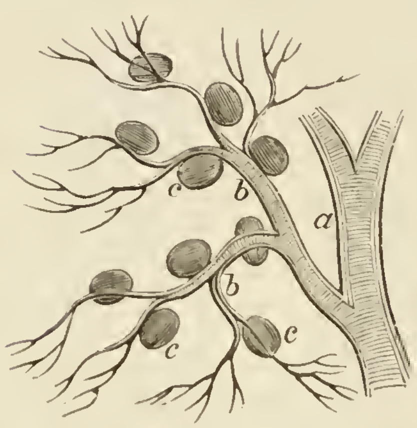


Fig. 163.—Portion of Splenic Artery, with Corpuscles of the Spleen attached to its twigs

a, A main artery; *b*, *b*, small arterial twigs; *c*, *c*, *c*, Malpighian corpuscles.

Structure of the Spleen.—The spleen is completely surrounded by peritoneum, excepting along its inner border where the vessels and nerves enter. Beneath the peritoneum is a strong but very elastic **capsule**; this is very firmly adherent and cannot be stripped off. From the capsule fibrous bands pass into the interior along the blood-vessels, and these, branching out in all directions, form a mesh-work which is firmly attached to the interior of the capsule, and divides the interior of the spleen into a great number of irregular spaces or **areolæ**. These interspaces are occupied by a reddish-brown, soft material, the **splenic pulp**, which, on microscopic examination, is found to consist of a net-work of branched cells, supporting broken-down red blood corpuscles, white blood corpuscles in large numbers,

and a few pigmented cells. The **arteries** distributed to the spleen, after breaking up into small branches, terminate in the splenic pulp without forming capillaries, and in like manner the small **veins** have their commencement in the pulp. Scattered throughout the spleen are numerous light-coloured spots, which, when of large size, present the appearance of sago grains. They are the **Malpighian corpuscles** of the spleen, and are simply masses of adenoid or lymphoid tissue situated on the terminal twigs of the splenic artery (see fig. 163).

The **artery** and **vein** of the spleen are very large in proportion to its size, and it is assumed that it has for its function the elaboration of the blood corpuscles and other blood elements. It cannot, however, be said that our knowledge as to its uses is satisfactory.

Supra-renal Body.—This is a very small and unimportant structure, placed at the upper end of the kidney and shaped somewhat like a cocked-hat. It is composed mainly of cells, has no duct, is freely supplied with blood-vessels and nerves, and is usually regarded as concerned in blood elaboration.

The Kidneys.—The **kidneys** are the organs for the secretion of the urine. They are placed one on each side of the vertebral column in the lumbar region, corresponding in position to the bodies of the last dorsal and two upper lumbar vertebræ, and extending from the lower ribs to the crest of the ilium. In consequence of the interposition of the liver on the right side, the right kidney is a little lower down than the left. Each kidney is between four and five inches in length, about two and a half inches in breadth, and somewhat more than an inch in thickness, and weighs about $4\frac{1}{2}$ ounces in the male and rather less in the female.

The right kidney is in contact with the liver, the left with the spleen; they both lie against the posterior abdominal wall, and have the large bowel in front of them. Their position in relation to the great vessels of the abdomen is shown in fig. 164, and their ducts, the **ureters**, are there shown passing down to the bladder. The upper expanded portion of the

ureter is called the **pelvis**, it corresponds in its position to a hollow on the inner side of the kidney called the **hilus**, where also the blood-vessels are placed. At this part the vein is always placed in front, the artery next, the ureter behind. The outer edge of the kidney is convex, the posterior surface a little flattened, the anterior surface convex, the upper end rather larger than the lower.

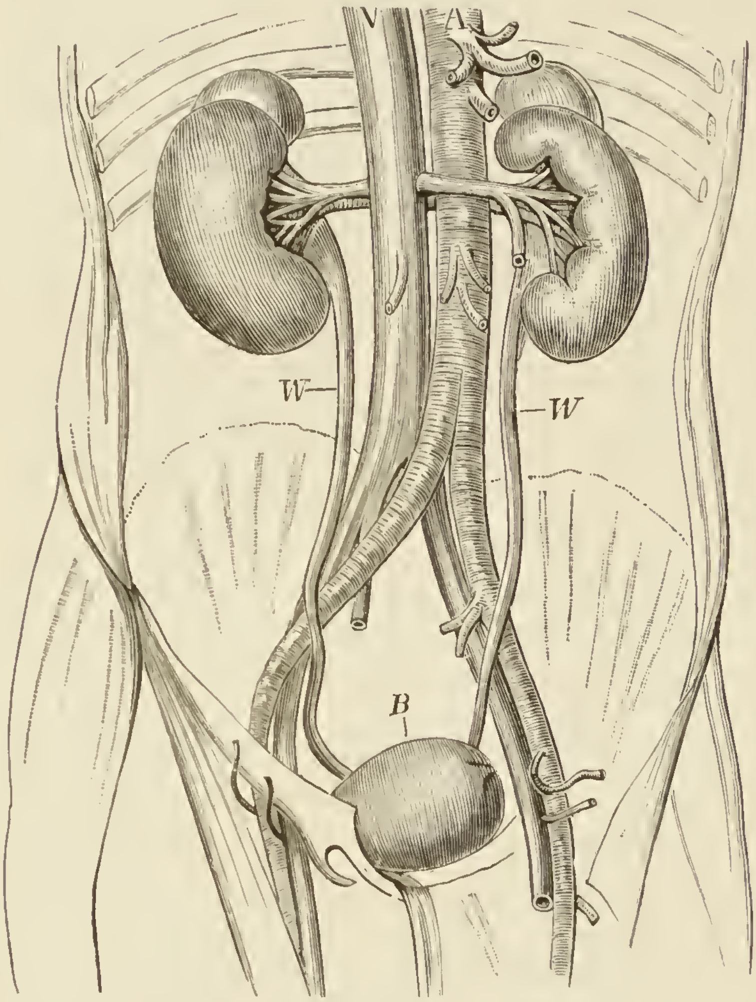


Fig. 164.—The Situation of the Kidneys.

A, aorta; V, inferior vena cava; B, bladder; W, ureters. Branches of the aorta are seen going to the kidney, and veins from it are shown joining the vena cava.

The kidney is surrounded by a thick layer of fat forming the **adipose capsule,** which, in the sheep and ox, is the chief source of suet; this separates the organ from the posterior abdominal wall behind and the peritoneum in front. The kidney is enclosed in a thin but firm, fibrous **capsule**, differing from that of the other organs we have described in being easily separable.

If the kidney be cut open in the direction of its length it presents the appearance shown in fig. 165. The outer part is seen to differ in colour and texture from the inner, hence the former is described as the *cortical*, and the latter as the *medullary* part. The **cortical** is distinguished by its bright, red colour, granular appearance, and softer texture; it forms the exterior of the organ, but also dips into the interior so as to divide up the **medullary** part into eight to fifteen dark-red,

conical masses, the **Malpighian pyramids**. The bases of these pyramids are directed outwards and gradually shade off into the cortical part; the apices form small conical projections, the **papillæ**, projecting into recesses of the pelvis known as the **calices**. The calices by their union form **infundibula**, and these unite to constitute the pelvis. At the summit of each papilla is a little depression, and opening into this are the terminations of eight or ten minute tubules, the **uriniferous tubules**. The tubules radiate from the papilla and run in straight lines till they reach the edge of the pyramid, when they at once become convoluted; after this each tube runs back again into the pyramid in a straight line, traverses about half the depth of the medulla, and again ascends into the cortex, where it becomes a second time convoluted, and terminates in a spherical expansion, the **Malpighian capsule**. The tubules are lined by a single layer of epithelial cells, but the character of the epithelium differs very much in different parts of the course of the tubule, and the size of the free channel left also varies. The portion of the tube which doubles back on itself in the pyramid is called the **looped tubule of Henle**, after the anatomist who first described it; it is narrow, and the channel in it is small.

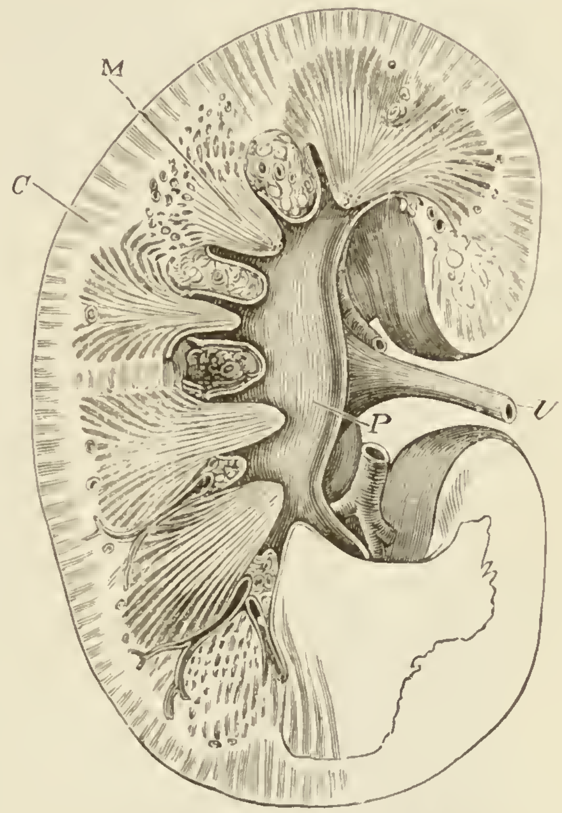
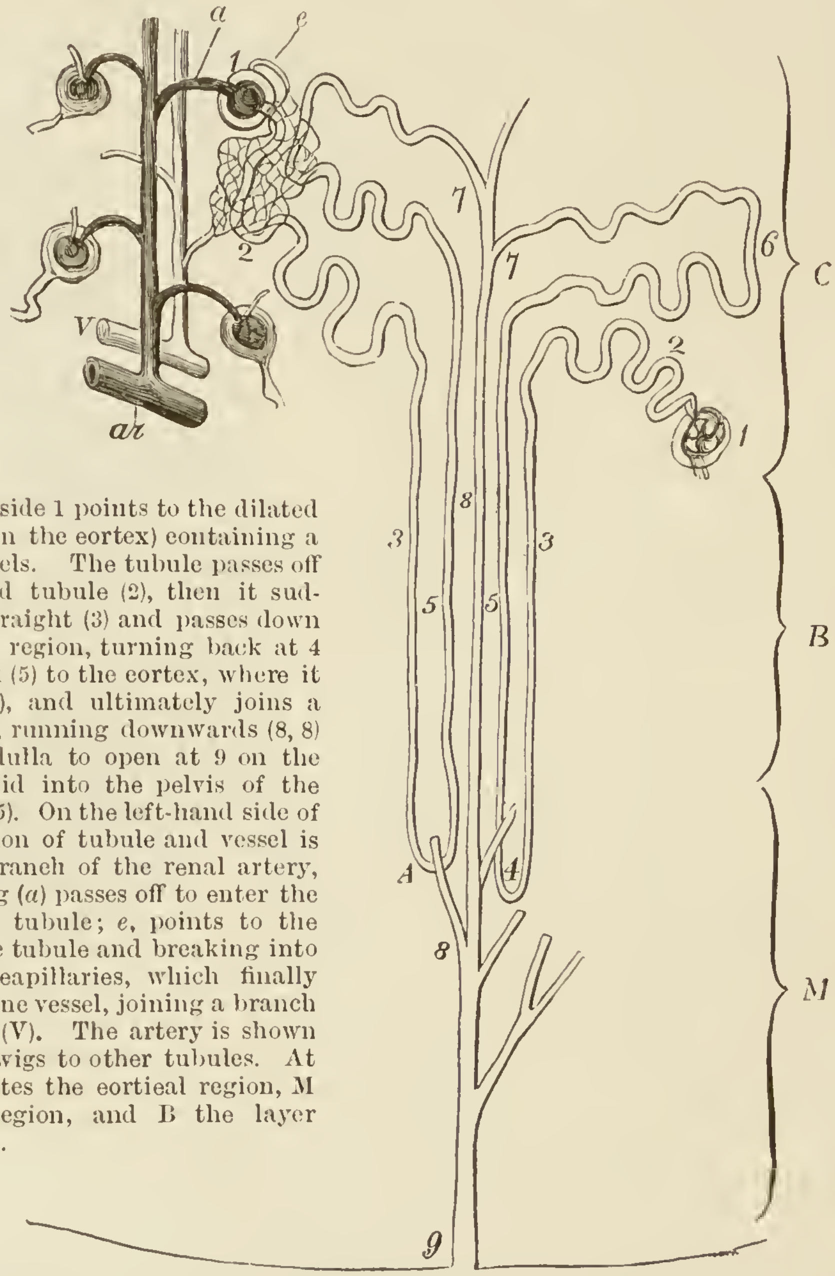


Fig. 165.—A Kidney opened in its length.

C, Cortical portion; M, medullary portion; P, pelvis; U, ureter.

The **arteries** of the kidney enter at the hilus, and run between the pyramids of Malpighi; at the base of these they divide into small branches which pass, for the most part, to the cortex, and are arranged in series between the groups of convoluted uriniferous tubules. From these **interlobular branches** twigs are given off on each side to the Malpighian

capsules, and receive the name of **afferent vessels.** Each vessel, after piercing the capsule, breaks up in the interior into a number of capillary vessels, each of which becomes greatly convoluted and forms a little ball. This ball is called the



On the right-hand side 1 points to the dilated end of a tubule (in the cortex) containing a tuft of blood-vessels. The tubule passes off as the convoluted tubule (2), then it suddenly becomes straight (3) and passes down to the medullary region, turning back at 4 and passing back (5) to the cortex, where it becomes wavy (6), and ultimately joins a straight tubule 7, running downwards (8, 8) through the medulla to open at 9 on the apex of a pyramid into the pelvis of the kidney (see fig. 165). On the left-hand side of the fig. the relation of tubule and vessel is shown: *ar* is a branch of the renal artery, from which a twig (*a*) passes off to enter the dilated end of a tubule; *e*, points to the vessel leaving the tubule and breaking into a meshwork of capillaries, which finally form again into one vessel, joining a branch of the renal vein (V). The artery is shown giving off other twigs to other tubules. At the side, C indicates the cortical region, M the medullary region, and B the layer bounding the two.

Fig. 166.—Diagrammatic View of the Tubules and Blood-vessels of the Kidney.

glomerulus or **Malpighian tuft**; the tuft and capsule together being spoken of as the **Malpighian body.** The blood contained in the glomerulus is carried away by a smaller vessel, the **efferent vessel**, and this passes to the convoluted portion of the tube, and breaks up into a plexus of capillaries which spreads over the surface of the tube. From this

plexus the veins originate; they leave the kidney at the hilus and empty into the inferior vena cava. The watery part of the urine is separated from the blood in the capillary of the glomerulus by a process of filtration. The salts are added in the convoluted part of the uriniferous tubule, being secreted from the blood in the efferent plexus by the epithelium lining that part of the tubule.

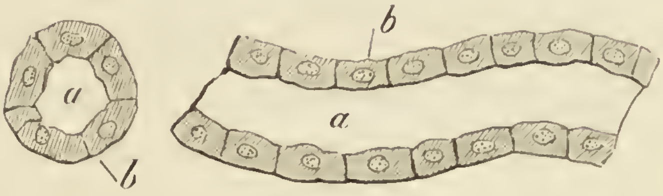


Fig. 167. — Very highly magnified View of Cross and Longitudinal Section of a Tubule. *b*, cells; *a*, channel of a tubule.

The kidney is supplied by an elaborate plexus of nerves, most of them belonging to the sympathetic system, and being connected with the solar plexus.

Ureter.—The ureter or duct of the kidney commences at the hilus of that organ by an expansion called the **pelvis** of the kidney. This is placed behind the blood-vessels, and lies against the muscles forming the back wall of the abdomen.

The ureter lies behind the peritoneum and passes down into the pelvic cavity to reach the under surface of the urinary bladder. In its course it runs down on the psoas muscle, and crosses the common iliac artery and vein. In the male it crosses the vas deferens (the duct of the testicle) before entering the bladder, and, in the female, runs by the side of the neck of the uterus and the upper part of the vagina.

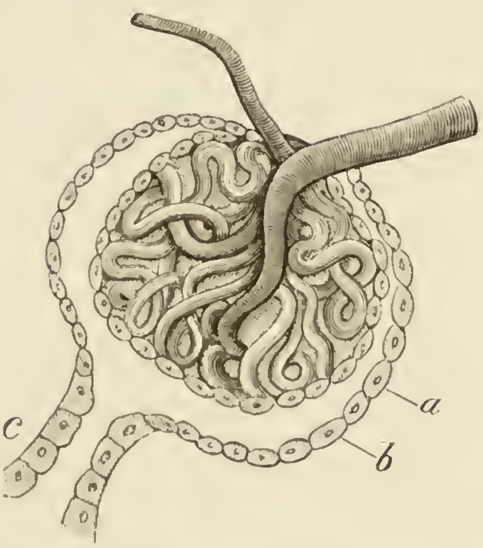


Fig. 168.—Malpighian Body of Kidney, with its tuft of vessels.

a and *b*, cells of capsule formed of dilated end of tubule *c*. The wide vessel is the afferent; the narrow one is the efferent. Very largely magnified.

The ureter is a membranous tube about eighteen inches in length, and about the diameter of a goose-quill. It is formed of three coats, external, middle, and internal. The first of these is composed of fibrous tissue, the second of longitudinal and circular unstriped muscular fibres, and the inner coat is

formed of mucous membrane, lined by a many-layered epithelium.

Pelvic Cavity.—The cavity of the pelvis is that part of the great abdominal cavity enclosed by the pelvic bones, and situated below the level of the brim of the pelvis (the ilio-pectineal line and promontory of the sacrum). The structures closing it in below form the **perineum**; the levator ani muscles and the pelvic fascia being the most important of them. At the sides it is limited by the innominate bones and the muscles lining them, and behind by the sacrum, coccyx, sacro-ischiatic ligaments, sacral nerves, and two pairs of small muscles (coccygeus and pyriformis).

The **viscera of the pelvis in the male** are—the urinary bladder, prostate gland, seminal vesicles, and rectum. **In the female** they are—the urinary bladder, vagina, uterus, ovaries, Fallopian tubes or oviducts, and rectum.

Male Urinary Bladder.—The bladder is a membranous bag, oval in shape when filled, triangular when empty, placed behind the pubes, and in front of and upon the rectum. It is larger from above downwards than from side to side, and its long axis is directed from above obliquely downwards and backwards. The middle part of it is called the **body,** the lower part the **base**, and the upper part the **fundus**, while the constricted portion connecting it with the urethra (or excretory channel) is called the **neck.** When the person is standing the neck of the bladder is at its lowest part. It lies behind the pubes, and is connected with that bone by bands of fascia, and by a layer of peritoneum. Below, it rests upon the rectum, seminal vesicles, duct of the testicle (vas deferens), and ureter; behind, a layer of peritoneum alone separates it from the small intestines, which occupy the greater part of the pelvic cavity, unless when the bladder is distended, or the uterus enlarged. The neck of the bladder is surrounded by the **prostate gland.** The **peritoneum** covers the whole of its posterior surface, and is continued from its fundus on to the inner surface of the pubes and abdominal wall; it also clothes the upper and posterior part of each lateral aspect. On the under surface, the peri-

toneum is continued as far forwards as the point where the ureters enter the bladder, and there ceases; the result being, that there is, at the front of the base, a small area, where it is possible to puncture the bladder from the rectum without injuring the peritoneum. Further, it should be noticed that the whole of the anterior surface is devoid of peritoneum, and that, consequently, when the bladder is fully distended, it is

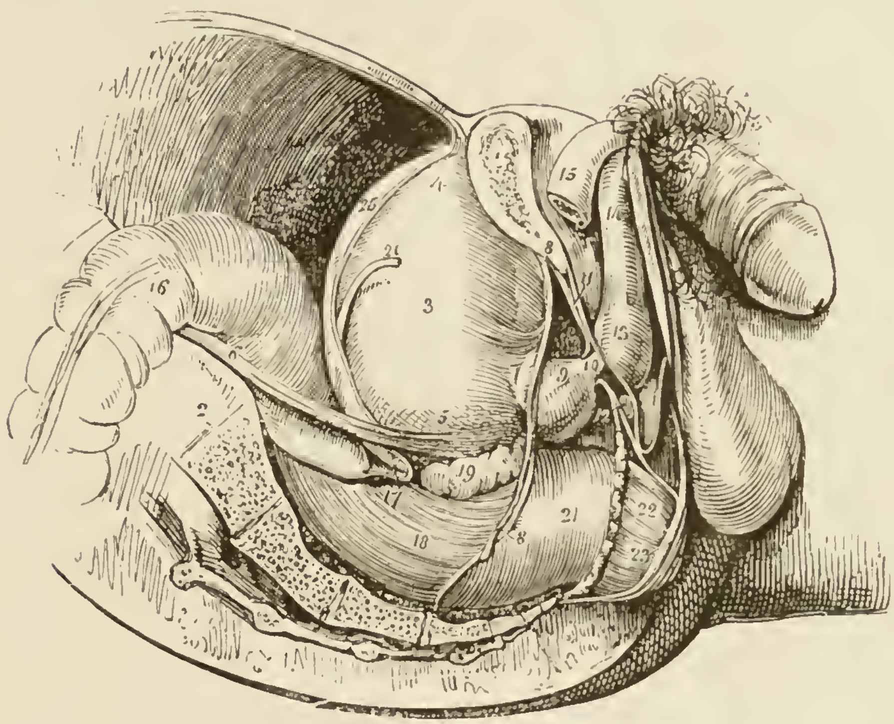


Fig 169.—Side View of the Male Pelvic Viscera. [Wilson.]

1, Pubic bone; 2, sacrum; 3, body of bladder; 4, fundus; 5, base; 6, ureter; 7, neck of bladder; 8, pelvic fascia; 9, prostate gland; 10, membranous part of urethra; 11, triangular ligament; 12, Cowper's gland; 13, bulb of urethra; 14, corpus spongiosum; 15, erus penis; 16, first part of rectum; 17, recto-vesical fold of peritoneum; 18, second part of rectum; 19, right seminal vesicle; 20, vas deferens; 21, rectum bending forward; 22, levator ani muscle; 23, external sphincter muscle of anus; 25, peritoneum covering back of bladder.

possible to tap it from above the pubes without any danger of injuring that membrane.

Structure of the Bladder.—On its exterior is the serous or **peritoneal coat,** which, as has just been shown, is only a partial covering. Next to this comes the **muscular coat,** formed of unstriped muscular fibre, forming a very complicated series of layers. Of these it is only necessary to distinguish two, namely, (1) longitudinal bands on the front and back of the bladder, and constituting the **detrusor urinæ,** or expeller of the urine; and (2) circular fibres around the neck, and form-

ing the **sphincter vesicæ**, or retainer of the urine. Within the muscular coat is a layer of areolar tissue, called the **submucous coat.** It serves to allow of the folding up of the mucous membrane when the viscus is empty, and also gives space for the distribution of vessels, nerves, and lymphatics. The inner coat of the bladder is formed by a thick and smooth **mucous membrane**, of a pale rose colour, continuous with that lining the ureters, and also with the mucous membrane of the urethra. It is covered by a stratified epithelium similar to that of the ureters, the deep cells being pear-shaped, and the superficial ones flattened.

On the inner surface of the floor of the bladder is a smooth triangular area, where the mucous membrane is paler and thinner than elsewhere, and is not thrown into folds when the viscus is empty; this is the **trigone.** Its posterior limit corresponds to the entrance of the ureters, and its anterior angle is at the neck of the bladder. On the under surface of the bladder the area of the trigone is indicated by the two ducts of the testicle, which form its lateral boundaries, and by a line drawn between the two ureters just as they enter the bladder wall. The trigone is the most sensitive part of the whole interior; it is always devoid of folds (even when the bladder is quite empty); it has no peritoneum in relation with it; the mucous membrane is thinner and paler than elsewhere; and, lastly, it is in intimate relation with the rectum.

The bladder is freely supplied with blood by vesical branches of the internal iliac artery, and with nerves by branches of the sympathetic and sacral nerves.

Prostate Gland.—The **prostate** is a musculo-glandular mass, placed in front of the neck of the bladder in the male, and surrounding the first part of the urethra; it is not present in the female. It is in close relation to the rectum, and can be felt in front of that canal, when the finger is introduced into the anus. In most cases it forms a single mass, but is sometimes divided into three lobes, the portion placed between and behind the seminal ducts forming a middle or **third lobe.** The latter (Home's lobe) is especially troublesome in old

age, for it undergoes enlargement (as does the whole gland), and seriously narrows the canal so as to cause retention of urine. The **muscular fibres** in the prostate are of the unstriped variety, and are continuous with those of the sphincter vesicæ. The **glandular element** forms nearly a fourth of the whole mass, and consists of a number of branched tubules, whose ducts pour out the secretion into the prostatic portion of the urethra.

Seminal Vesicles.—These are two irregular lobulated bodies placed on the under surface of the base of the male bladder, one of them lying immediately to the outer side of each duct of the testicle (**vas deferens**). Each vesicle is formed by the convolutions and branches of a single tube, and terminates by uniting with the vas deferens to form a common canal, the **ejaculatory duct.** The latter traverses the substance of the prostate gland, and opens into the prostatic portion of the urethra. The seminal vesicles are lined by a thin mucous membrane, which is covered by a squamous epithelium, and has opening on to its surface a number of mucous glands. The vesicles serve to store up the seminal fluid, and also add their mucous secretion to it.

Male Generative Organs.—These are the penis and testicles.

The Penis.—The **penis** is covered by a very fine, thin, elastic skin, studded with a few hairs, and containing a small amount of pigment. At the base of the organ the hairs become more numerous, and form a large tuft over the pubic bone; they are also continued on to the scrotum. At the free end of the penis the skin forms a sheath for the extremity of the organ, and is called the **prepuce**; its inner surface assumes the character of mucous membrane, and becomes continuous with the mucous covering of the glans penis.

The penis consists of three parts: a *corpus spongiosum*, placed in the middle line and below, and a *corpus cavernosum* on each side and above; each of the latter being much larger than the former. The two **corpora cavernosa** diverge posteriorly, and each ends in a triangular process, the **crus penis**, by which it

becomes fixed to the ramus of the pubic bone. In front they become fused together, the line of their union being marked by a fibrous division.

The **Corpus spongiosum** is attached at its back part to a strong layer of fascia, filling in part of the pubic arch, and called the **triangular ligament**; it is here enlarged so as to form a rounded prominence, named the **bulb of the urethra.** At the free end of the penis the corpus spongiosum becomes also enlarged, and forms a conical mass, the **glans penis**, projecting beyond the corpora cavernosa, and firmly united to their extremity. The glans is covered by a thick mucous membrane of a pink colour, studded over by fine papillæ, and freely supplied with blood-vessels and nerves. Around the glans is a deep groove, the **corona of the glans**, where the mucous membrane and skin become continuous, and in which are numerous sebaceous glands secreting a thick fluid. The corpus spongiosum is traversed by a canal for the conveyance of the urine, the **urethra**, and this terminates in a vertical slit at the lower border of the glans, the **meatus urinarius.**

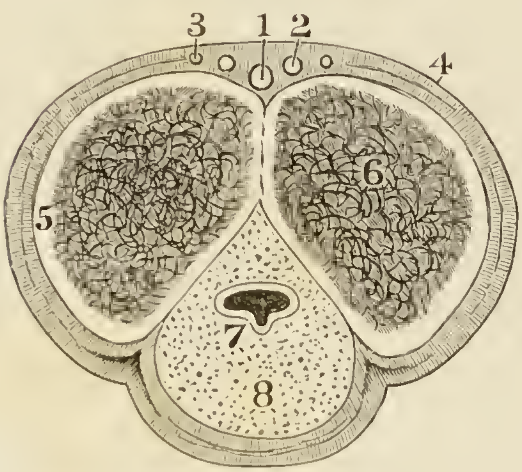


Fig. 170.—Transverse Section of the Penis.

1, Dorsal vein of penis; 2, dorsal artery; 3, dorsal nerve; 4, skin; 5, fibrous capsule; 6, corpus cavernosum; 7, urethra; 8, corpus spongiosum. [A. M'Alister.]

In **structure**, the penis consists of a number of irregular spaces, in free communication with numerous arteries and veins, and formed by connective tissue with a lining of epithelium; this arrangement constitutes what is known as **erectile tissue.**

Testicles.—The **testicles** are the organs which secrete the seminal fluid. They are two in number, and are contained in a bag placed beneath the penis and called the *Scrotum.*

The **Scrotum** is divided into two halves by a vertical ridge, the *raphè*, and is formed of lax and elastic skin containing a considerable quantity of unstriped muscle. In its interior is a

septum or division formed of fibrous tissue, and dividing the cavity into two sacs for the two testicles.

The **Testicle** is an oblong gland about an inch and a half in length, suspended in the scrotum by means of its duct, the **vas deferens.** It is a little flattened on each side, and its front edge looks outwards and forwards. As a rule the left testicle hangs slightly lower down than the right. Lying against its posterior border is a lobulated mass, the **epididymis,** continuous at its lower end with the vas deferens; this projects above the testicle and forms a lobule called the **globus major,** while a smaller lobule, reaching to a little below the bottom of the organ, is called the **globus minor.**

On the front of the testicle is a closed sac, the **tunica vaginalis.** This, when first formed in the child, was continuous with the peritoneal cavity, but gradually got shut off. In the adult the membrane covers the front and outer side of the testicle, and to a less degree the inner surface, but does not extend round to the back of it.

Beneath the tunica vaginalis is a white shining layer, the true capsule of the testicle, called **tunica albuginea.**

The mass of the testicle is formed of lobules, each of them composed of a minute tubule, very much coiled up, and lined by cells which give origin to the spermatic cells or **Spermatozoa.** The tubules all empty into a series of channels in a fibrous mass at the back of the body of the testicle, and these are in direct connection with the tubes forming the globus major of the epididymis. After traversing the whole length of the epididymis the seminal fluid reaches the vas deferens, and by it is conveyed to the prostatic portion of the urethra.

The name of **Spermatic Cord** is given to the whole of the structures by means of which the testicle is placed in communication with the cavity of the abdomen. It is composed of the spermatic arteries and veins, lymphatics, nerves, and the vas deferens or duct of the testicle. It is enclosed in certain layers derived from the abdominal wall, called the **coverings of the cord,** carried down by the testicle in its descent into the scrotum.

Descent of the Testicle.—The testicle is formed in the abdominal cavity immediately below the kidney, and remains in that situation until about the fifth or sixth month of intra-uterine life, when it begins to descend. It makes its way through the internal abdominal ring into the inguinal canal, traverses it, escapes at the external abdominal ring, and passes down into the scrotum, which it reaches about the end of the

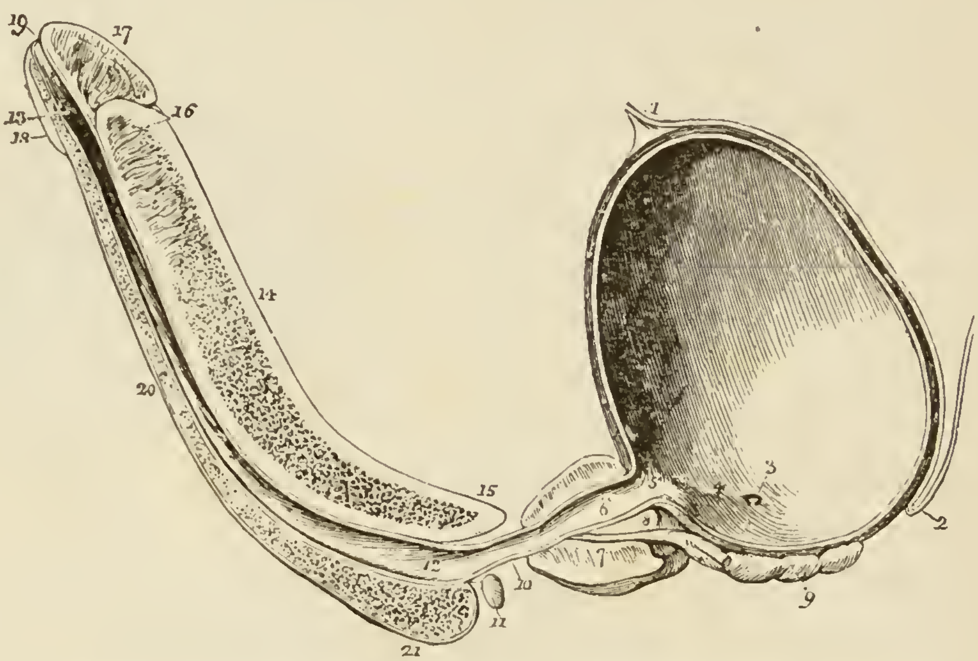


Fig. 171.—Longitudinal Section of the Penis, Prostate Gland, and Bladder, showing the Urethra.

1, Cord passing up to navel; 2, recto-vesical fold of peritoneum; 3, opening of right ureter; 4, ridge formed by muscle of the ureter; 5, neck of bladder; 6, prostatic part of urethra; 7, prostate gland; 8, middle lobe of prostate; 9, right seminal vesicle; 10, membranous part of urethra; 11, Cowper's gland; 12, bulbous part of urethra; 13, fossa navicularis; 14, corpus cavernosum; 15, right crus penis; 16, septum between the two cavernous bodies; 17, upper part of glans penis; 18, lower part of glans; 19, meatus urinarius; 20, corpus spongiosum; 21, bulb of urethra. [Wilson.]

seventh month. Sometimes it is retained in the abdomen or in the inguinal canal, and is then spoken of as an **undescended testicle**.

Male Urethra.—The **urethra**, or canal which conducts the urine away from the bladder, is in the male about eight inches in length, commencing at the neck of the bladder and terminating at the meatus urinarius at the extremity of the glans penis. It is curved in its course, and traverses the prostate gland and the corpus spongiosum of the penis.

In **structure** it consists of three coats, *muscular*, *submucous*, and *mucous*. The **muscular coat** is most external and is

formed of circular and longitudinal unstriped muscular fibres. Next to this is a **submucous coat**, composed of areolar and vascular tissue, and lodging racemose mucous glands, the ducts of which open on to the surface of the mucous coat. The **inner coat** is formed of **mucous membrane**, continuous at its inner end with that of the bladder, and at the other with that covering the glans penis. It is lined with a stratified squamous epithelium, and has opening on to its surface numerous mucous recesses, the ducts of the glands in the submucous tissue (*glands of Littre*), the ducts of Cowper's glands, and those of the prostate gland; and lastly, the common ducts formed by the union of the vas deferens and seminal vesicle on each side.

The male urethra is divided into a *prostatic*, *membranous*, and *spongy portion.*

The **Prostatic portion** of the urethra is that part traversing the prostate gland; it is the widest part of the whole canal, and measures about one and a quarter inches in length by about half an inch in breadth. On the floor of the prostatic urethra is a slight ridge called the **veru montanum**, and on each side of it a shallow groove (the **prostatic sinus**), into which the ducts of the prostatic glands empty. In front of the veru is a small pouch, the **sinus pocularis**, sometimes regarded as the representative in the male of the womb in the female, and on each side the **ejaculatory ducts** (formed by the union of the vas deferens and seminal vesicle) terminate.

The **Membraneous part** is the narrowest and most fixed portion of the canal. It passes through a dense layer of fascia, called the triangular ligament, situated beneath the arch of the pubes.

The **Spongy portion** forms the largest part of the urethra, being about six inches in length. Its entire course is in the substance of the corpus spongiosum of the penis. The part nearest the triangular ligament is called the **bulbous portion**, because the corpus spongiosum there undergoes a bulbous enlargement; it receives the ducts of two small glands placed beneath and behind the bulb, and named **Cowper's glands.**

The terminal portion is called **glandular**, because contained in the glans penis; it is a little dilated so as to form a space named the **fossa navicularis**. The **meatus urinarius** is the narrowest part of the urethra, and an instrument which will pass through it should traverse the whole canal without difficulty.

Pelvic Organs in the Female.—The Bladder.—In the female, the **bladder** is placed between the pubes and

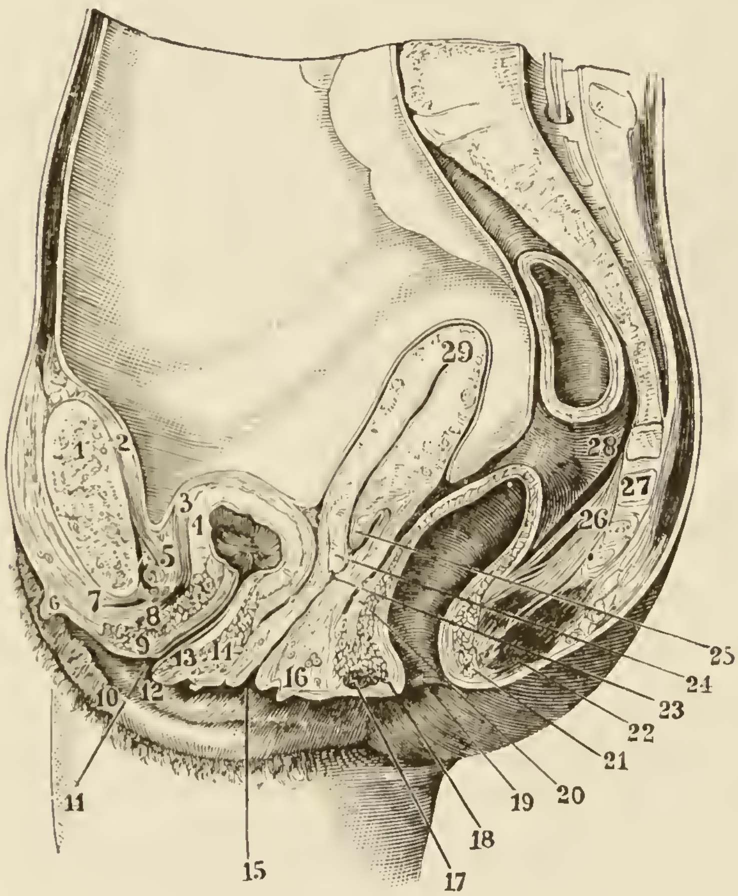


Fig. 172.—Vertical Section of the Female Pelvic Organs.

1, Pubic symphysis; 2, peritoneum; 3, outer layer of bladder wall; 4, inner layer; 5, retro-pubic fat; 6, clitoris; 7, vein of dorsum of clitoris; 8, transverse perineal muscle; 9, circular muscular fibres of urethra; 10, labium major; 11, meatus urinarius; 12, nympha; 13, longitudinal muscular fibres of urethra; 14, deep circular fibres; 15, orifice of vagina; 16, perineal body; 17, external sphincter ani; 18, internal sphincter; 19, anus; 20, recto-vaginal fold of peritoneum; 21, posterior part of internal sphincter ani; 22, back part of external sphincter; 23, vagina; 24, anterior lip of os uteri; 25, posterior lip of os; 26, levator ani; 27, sacrum; 28, rectum; 29, uterus. [Wilson, after Henle.]

the uterus, and is separated from the former by some loose fat (retro-pubic fat), and from the latter by one or more folds of small bowel, and two layers of peritoneum. Below, it lies against the anterior vaginal wall and the neck of the uterus. Its connection with the vagina is so intimate that the floor of the bladder is occasionally injured during the birth of a child, a *vesico-vaginal fistula* (or communication between the bladder and vagina) resulting.

The Urethra.—The **Urethra** in the female is very short as compared with that of the male. It is lodged in the upper and anterior wall of the vagina, is widest at the neck of the

bladder, and curves downwards and forwards beneath the pubic arch to terminate in the meatus urinarius, the narrowest part of the canal. The **meatus** opens into the vestibule, beneath the lesser labia or nymphæ, and in front of the orifice of the vagina.

The Vagina.—The **Vagina** is the canal leading from the exterior of the body to the womb (uterus). It runs in the axis of the outlet of the pelvis, and is placed between the bladder and urethra in front and the rectum behind. The anterior and posterior walls are in loose contact, excepting at the upper part of the canal, where it is dilated and has projecting into it the lower end of the uterus. The vagina measures about five or six inches along its posterior wall, and four inches on the anterior, it is narrowest at the external orifice, and there forms a mere vertical slit. Its upper part is covered by a layer of peritoneum, which passes from this organ to the back of the rectum, and is called the **recto-vaginal pouch**, or **fold of Douglas**; an instrument pushed into the vagina may pierce its upper wall and enter the cavity of the peritoneum.

Structure of the Vagina.—The vaginal wall is formed of three layers or coats. The **Outer coat** is formed of areolar tissue in which there is a considerable admixture of elastic fibres; it serves to connect the vagina with the neighbouring parts. The **Middle coat** consists of unstriped muscular fibres arranged in longitudinal and circular bundles. The **Internal coat** is formed of mucous membrane arranged in numerous folds (*rugæ*), disposed transversely and connected by a longitudinal ridge on the anterior and posterior wall. These folds are absent from the upper part of the canal where it receives the uterus. The **mucous membrane** is studded with numerous fine papillæ, and is covered by a stratified epithelium, the surface cells of which are squamous and very large; there also open on to the surface a large number of mucous glands.

The Uterus.—The **Uterus** or **Womb** is a pear-shaped organ occupying the pelvis, and having its upper end directed

upwards and forwards, and its apex downwards and backwards. It is placed between the rectum and bladder, and is held in its proper position by a double fold of peritoneum stretching from side to side of the pelvic cavity and forming the **broad ligaments**. The lower end projects into the anterior wall of the vagina, and the cavity of the uterus is continuous with that of the vagina. The womb varies much in its position, even in health; this depending on the varying conditions of the bladder, rectum, &c. It is divided into a **fundus** or **body**, and a **cervix** or **neck**. The fundus is enclosed in the peritoneal layers of the broad ligaments; the front layer, however, only covers the upper two-thirds of the organ, and is continued from it on to the bladder; the back layer envelops the whole posterior wall, and is continued on to the vagina and from thence on to the rectum. From the upper part of the fundus a long tube passes off on each side, the **Fallopian tubes**, or **oviducts**, the cavity of each being continuous with that of the uterus. Between the fundus and cervix is a well-marked constriction, formed by a circular band of muscular fibres.

The **Cervix** or **Neck** of the womb projects into the upper part of the vagina and is placed on its anterior wall; it ends in a rounded projection in which is an opening, the **os uteri**, bounded in front and behind by thickened edges receiving the name of the **anterior** and **posterior lips** (*labia*) of the os.

The **Cavity** of the uterus is triangular in shape, and the upper angles are continuous with the cavity of the two Fallopian tubes. The lower angle forms a narrow opening, the **os internum**, between which and the opening into the vagina is a small oval secondary space, the **cavity of the cervix**.

The uterus has thick walls and is capable of distension to a very great size during pregnancy, returning to nearly its former dimensions after the birth of the child. It is formed of three coats, *outer*, *middle*, and *internal*. The **Outer coat** is peritoneal, and (as described above) forms only a partial investment in front and a complete one behind. The **Middle coat** consists of unstriped muscular fibres forming many layers, some running

in the length of the organ, others passing round it horizontally, and others, again, traversing it obliquely in various directions. Around the neck the fibres are chiefly circular, but are connected with the longitudinal fibres of the body, and similar circular bands surround the openings of the Fallopian tubes. A large plexus of veins occupies the middle of the muscular coat and gives it rather a spongy appearance on section. The **Inner coat** is formed by mucous membrane of a pale pink colour, very firmly adherent to the inner surface of the

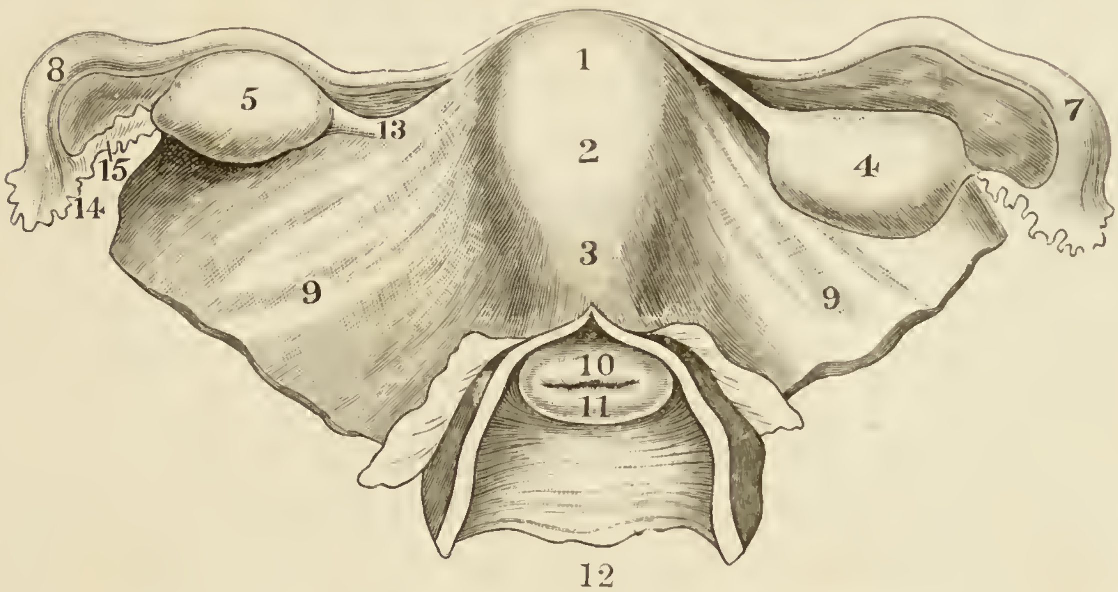


Fig. 173.—The Uterus and its Appendages, seen from behind.

1, Fundus of uterus; 2, body; 3, cervix; 4, right ovary; 5, left ovary; 6, upper part of broad ligament; 7, right Fallopian tube; 8, left Fallopian tube; 9, 9, lower part of broad ligaments; 10, posterior lip of os uteri; 11, anterior lip; 12, vagina; 13, ovarian ligament; 14, fimbriated end of Fallopian tube; 15, tubo-ovarian ligament. [Thomas.]

muscular coat. It has in its substance a large number of mucous glands, the **uterine glands**. They are for the most part simple follicles, but some are divided into two in their deep part, and others are spirally twisted. They are lined by a single layer of prism-shaped epithelial cells, those at the neck of the gland being provided with fine cilia. The glands undergo great enlargement during pregnancy. The mucous membrane is lined by a columnar ciliated epithelium. The membrane of the cervix is firmer and thicker than that of the body; it is raised into oblique ridges, producing a peculiar configuration called the **arbor vitæ uterinus** or **palmæ plicatæ**.

Between the folds a number of glands open, and these secrete a peculiar transparent mucus.

The womb is held in its place (1) by the double peritoneal folds already described as the **broad ligaments**, (2) by the **round ligaments**. The latter are cord-like structures passing from the uterus near its upper extremity on each side to the internal abdominal ring. They traverse the inguinal canal, and, passing through the external abdominal ring, terminate in the mass of fat over the pubes (the *mons Veneris*). The womb is freely supplied with blood by the uterine arteries derived from the internal iliacs, and the ovarian arteries from the abdominal aorta. The nerves distributed to it are derived from the sympathetic and sacral nerves.

Fallopian Tubes.—The **Fallopian tubes** or **oviducts** are two long and narrow tubes, whose function is to convey the ovum from the ovary. They are situated in the upper, free border of the broad ligament, and the narrow inner end of each tube is continuous with the upper angle of the womb. Each tube is about four inches in length, runs a rather flexuous course, and terminates in a trumpet-like expansion or **ampulla.** The expanded end is surrounded by a double or triple fringe of fine processes—the **fimbriated extremity**—and in the centre of these is a small opening (the **abdominal pore**) leading into the tube, and through it communicating with the cavity of the uterus. One of the fringe-like processes (longer and stronger than the rest) passes to the outer end of the ovary, forming a **tubo-ovarian ligament.**

Structure.—The Fallopian tube has three coats:—an outer one of peritoneum, a middle of longitudinal and circular unstriped muscular fibres, and an inner of mucous membrane. In the condition of rest the mucous membrane is thrown into longitudinal folds; it is lined by a single layer of cubical, ciliated, epithelial cells, which are also continued on to the inner surface of the fringe processes. The motion of the cilia is always towards the uterine cavity. The mucous membrane is continuous with that lining the uterus, and at the edge of the fringes with the peritoneum. The peritoneal cavity in this

way communicates with the cavity of the uterus, and through it with the vagina and exterior of the body; it is not, therefore, a completely shut sac in the female.

The Ovaries.—The **Ovaries** are the organs which form the ova. Each ovary hangs from the posterior surface of the broad ligament and is connected with the uterus by a special ligament (**ovarian ligament**), and with the Fallopian tube by the tubo-ovarian ligament. It is oval in shape, of a whitish colour, and generally shows little cicatricial depressions (**corpora lutea**) on its surface, where the vesicles containing the ova have been ruptured.

Structure.—The ovum has externally a covering of cells continuous with those of the peritoneum, but differing from the cells of the latter in being columnar or prismatic instead of squamous; the surface in consequence presenting a dull appearance instead of the shining character a serous membrane generally has. These cells are described as **germ epithelium**, because it is believed that they penetrate to the interior of the organ, and there give origin to the ova and their vesicles.

Beneath the epithelial layer is a strong fibrous capsule, the **tunica albuginea**, similar to the structure of the same name in the testicle.

The mass of the ovary is composed of white fibrous tissue, mixed with elastic tissue, and containing an unusual proportion of nuclei. In this **stroma**, spherical vesicles known as the **Graafian vesicles** are everywhere distributed. Those immediately beneath the surface are usually small, and those in the centre are less numerous but much larger. It will, however, commonly be found that one (or more) of the larger ones has got near to the surface by pushing aside the small vesicles, and that the tissues over it are undergoing thinning. Had the ovum remained in the living body the vesicle would in a short time have burst, and extruded its contents on to the free surface of the ovary.

Each **Graafian vesicle** has around it a little thickened stroma (the **fibrous tunic**), and within this a lining of epithelial cells. The cavity is occupied by a small quantity of fluid,

crowded with epithelial cells; and the latter are especially thickly heaped together at one part to form an eminence, the **germinal eminence**. In the midst of these heaped-up cells is a small spheroidal nucleated cell, the **ovum**.

Ovum.—The ovum measures about $\frac{1}{125}$ of an inch in diameter. It has a definite cell-wall, the **vitelline membrane**; cell-contents called the **yelk** or **vitellus**; a nucleus, the **germinal vesicle**, and inside this a nucleolus, the **germinal spot**. When the ovum is extruded from the ovary, by the rupture of the Graafian vesicle, it is received into the expanded end of the Fallopian tube, in consequence of the fringes of the latter being applied to the external surface of the ovary. After the ovum is thus expelled, the ruptured vesicle is filled with blood which in a few days becomes of a yellow colour, and hence the name of **corpus luteum** (yellow body) is given to the remains of the Graafian vesicle.

The ovary is supplied with blood by the ovarian and uterine arteries and with nerve filaments by the sacral and sympathetic nerves.

External Organs in the Female—Mons Veneris.—At the lower part of the abdomen, covering the pubes, is a mass of fat and fibrous tissue, clothed with skin supplied by a thick tuft of hairs, and is named the Mons Veneris. It receives the terminal extremities of the two round ligaments of the uterus.

The **Labia Majora** (greater lips) are two folds of skin, placed one at the inner side of each thigh at its junction with the body, and enclosing the genital opening. They contain areolar tissue and fat, and are covered on their outer surface with hair continued on to them from the mons Veneris. The urino-sexual fissure within them is called the **Vulva**. The joining of the greater lips in front is called the **anterior commissure**, and that behind the **posterior commissure**; within the latter is a small transverse fold, the **fourchette**, and internally to this a depression, the **fossa navicularis**. Behind the posterior commissure a thick mass of tissue covered with skin intervenes between the vulva and anus, it is the surface part of the sep-

tum between the rectum and vagina, and is named the **perineal body**, but by the accoucheur is called the **perineum**.

Inside the greater lips are two smaller folds, the **Labia Minora** or **Nymphæ**. Within the anterior commissure they divide into two processes, which surround the extremity of the clitoris and constitute its **prepuce**. As they pass backwards they diminish in size, and finally are lost in the sides of the opening of the vagina.

Fig. 174.—External Genital Organs of the Female.

1, Mons Veneris; 2, anterior commissure; 3, labium major; 4, nympha; 5, clitoris; 6, urethra; 7, hymen; 8, vagina; 9, fossa navicularis; 10, posterior commissure. [Thomas.]

The **Clitoris** is representative in the female of the penis in the male, and is placed immediately behind the anterior commissure. It arises by two processes (**crura clitoridis**) from the pubic arch; these unite to form a **corpus cavernosum**, and the organ terminates in a highly-sensitive **glans** similar to that of the penis.

Below the clitoris is a triangular area, called the **vestibule**, bounded on each side by the labia minora and behind by the opening of the vaginal canal. It is covered by mucous membrane, and has near its centre the opening of the urethra, the **meatus urinarius**. To find the urethral opening and introduce the catheter, the tip of the index finger should be introduced into the aperture of the vagina, and then drawn a little forwards; the opening will then be distinguished as a ring with a slightly-raised edge, and the catheter can be made to slide along the finger to the aperture. This can, with a little practice, be accomplished beneath the bed-clothes, and without any exposure of the patient.

Behind the vestibule is the **opening of the vagina**, which is a vertical slit with the sides in loose contact. In children this

is guarded by a partial septum of mucous membrane, the **hymen**, forming most frequently either a semilunar fold or a circular one with a hole in the centre. After the hymen is ruptured the remains of it are seen as a fringe of papillæ at the sides of the vaginal entrance; these have received the name of **carunculæ myrtiformes.**

The mucous membrane of the vulva is composed of areolar and elastic tissue, devoid of fat, and supplied very freely with blood-vessels. Its epithelium is stratified, the surface cells being squamous and of very large size. In the vestibule and clitoris there are venous masses and cavernous spaces, representing the erectile tissue of the male organs. On each side of the opening of the vagina is a small gland, corresponding to Cowper's glands in the male; they are called the **glands of Bartholin** or **Duvernay**. On the inner surface of the lesser and greater labia, around the urethral opening, and at the vaginal entrance are sebaceous glands, and mucous glands are found in the vestibule and vagina.

Nerves are freely supplied to these parts by the sympathetic and sacral nerves.

Mammary Glands.—The **mammary** or **milk glands**, two in number, are placed on the front of the chest wall, on the surface of the pectoralis major muscles, and occupy in the female the interval between the second and sixth intercostal spaces. Each gland is embedded in fat, and enclosed by a strong sheet of superficial fascia: it is rather elliptical in shape, the long axis corresponding to the line of the fibres of the pectoral muscle. The left is usually rather larger than the right.

In the centre of the convex exterior of the gland is a conical elevation, the **nipple** (mamilla), and around it a ring of modified skin, the **areola**. The colour of the areola is pale pink in the virgin, but after conception it assumes a brownish tint, and retains that hue throughout the remainder of life. The surface of the areola is slightly raised here and there in consequence of the presence of numerous sebaceous follicles. These become especially active during pregnancy and lactation, their

secretion serving to lubricate the nipple and parts around. The apex of the nipple has numerous openings for the terminations of the galactophorous or milk ducts. They lie between fine papillæ, with which the nipple is studded. Structurally, the nipple consists of the milk ducts and of areolar unstriped muscular tissue, the latter conferring on it the power of contraction.

Structure of the Mammary Gland.—The breast is a racemose gland, composed of from 15 to 25 lobes, held together by connective and adipose tissue. The lobes are of irregular size and shape, and are made up of smaller lobules, and these in turn are formed of **gland vesicles** or **alveoli.** Each gland vesicle is about $\frac{1}{200}$ of an inch in diameter, and is lined by cubical or columnar epithelial cells, varying greatly in their size and appearance as the gland is active or quiescent. The vesicles open into gland ducts, and these join to form larger ones, the largest receiving the name of **galactophorous ducts**, and terminating on the surface of the nipple. The terminal ducts, as they pass beneath the areola, become dilated so as to form elongated sacs, each of which is called an **ampulla.**

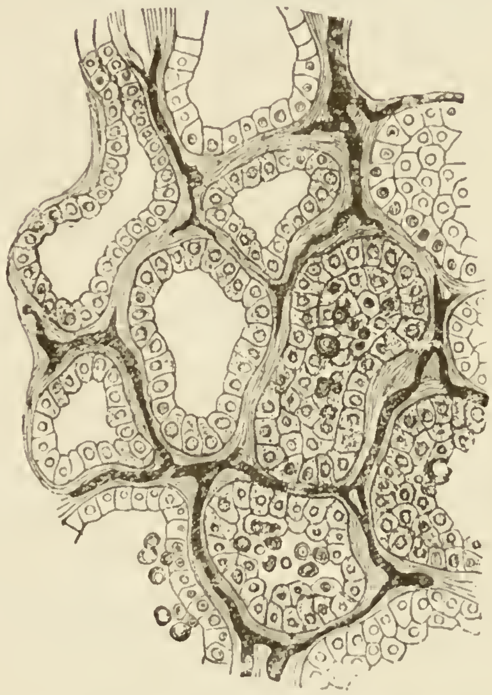


Fig. 175.—Gland Vesicles of the Mammary Gland during Lactation, showing the lining cells and capillary vessels. [Wilson.]

The **secretion of milk** takes place by the cells lining the gland vesicles having oil-globules formed in them. The cells become detached in consequence of new ones being formed beneath them, and on being set free burst and extrude their oil-globules, now become **milk-globules**. The latter float in a fluid, the **milk-plasma**, the two together constituting the **milk**.

The foregoing particulars relate to the female breast. In the male the organ is quite rudimentary, and does not measure

more than one or two inches in breadth and a quarter of an inch in thickness. It is not lobulated, and the ducts do not form ampullary dilatations.

The blood supply of the breast is derived from branches of the axillary, intercostal, and internal mammary arteries. The distribution to the female breast is a very free one, especially during the period of commencing lactation. The lymphatic vessels terminate in the glands of the arm-pit, but also form communications with the lymphatics in the chest, through the intercostal spaces.

GLOSSARY.

Abdomen (Lat. *abdo*, I conceal). The lower cavity of the trunk, containing the alimentary canal, liver, &c.

Abductor (Lat. *abduco*, I draw from). A muscle which draws a limb from the mid-line of the body, or a finger or toe from the mid-line of the foot or hand.

Acetabulum (Lat. *acetabulum*, a small vinegar-cup). The cup-shaped cavity on the innominate bone for receiving the head of the femur.

Acromion (Gk. ἄκρον, the tip, and ὦμος, the shoulder). The part of the scapula forming the tip of the shoulder.

Adductor (Lat. *adduco*, I draw to). A muscle which draws towards the middle line of the body, or of the hand or foot.

Afferent (Lat. *ad*, to, and *fero*, I convey). Vessels or nerves carrying the contents or impulses from the periphery to the centre.

Amœboid (Gk. αμειβω, I change, and εἶδος, like). Motion similar to that of the *Amœba*.

Amphiarthrosis (Gk. ἀμφί, both, and ἄρθρόν, a joint). An articulation with limited motion due to the elastic connecting substance, such as that between the bodies of the vertebræ.

Ampulla (Lat. *ampulla*, a wine-flask). The dilated part of the semicircular canals of the internal ear.

Anastomosis (Gk. ἀνά, by, and στόμα, a mouth). The intercommunication of vessels.

Angeiology (Gk. ἀγγεῖον, a vessel, and λόγος, a treatise). The description of vessels.

Antrum (Lat. *antrum*, a cave). The cavity in the upper jaw.

Anus (Lat. *anus*, an opening). The termination of the large bowel, serving as an outlet for the fæces.

Aorta (Gk. ἀορτήρ, a strap to hang anything to). The main artery of the body, proceeding from the heart.

Appendices epiploicæ. Little pellets of fat attached to the large intestine.

Arachnoid (Gk. ἀράχνη, a spider's web, and εἶδος, like). The middle membrane of the brain and spinal cord.

Areolæ (Lat. dim. of *area*, a void space). Interstices in fibrous tissue.

Artery (Gk. ἀήρ, air, and τηρέω, I keep). A vessel carrying blood from

the heart. So called because the ancients supposed the arteries to carry the "vital spirits".

Arthrodia (Gk. ἄρθρόν, a joint). A gliding joint.

Arthrology (Gk. ἄρθρόν, a joint, and λόγος, a discourse). A treatise on joints.

Articulation (Lat. *articulus*, a joint). The union of bones to form joints.

Arytenoid (Gk. ἀρυταινα, a pitcher, and εἶδος, like). Two cartilages of the larynx are so called, because together they are supposed to resemble the mouth of a pitcher.

Astragalus (Gk. αστράγαλος, a die). One of the tarsal bones.

Atlas (Gk. τλάω, I support). The vertebra supporting the head.

Auditory (Lat. *audio*, I hear). Belonging to the ear.

Auricle (Lat. *auricula*, a little ear).

Azygos (Gk. α, without, and ζυγός, a yoke). Without fellow; not paired.

Basilar (Lat. *basis*, a base). Belonging to the base of the skull or brain.

Basilic (Gk. βασιλικός, royal). Chief.

Biceps (Lat. *bis*, twice, and *caput*, a head). Having two heads.

Bicuspid (Lat. *bis*, twice, and *cuspis*, a spear). Having two tubercles.

Brachial (Lat. *brachium*, an arm). Belonging to the arm.

Bronchi (Gk. βρόγχος, the windpipe). The air tubes passing to the lungs.

Buccinator (Lat. *buccina*, a trumpet). The trumpeter's muscle.

Bursa (Lat. *bursa*, a sac). A closed sac containing fluid, used to modify pressure.

Cæcum (Lat. *cæcus*, blind). The expanded commencement of the large intestine.

Calices (Lat. *calix*, a cup). The cup-like cavities into which the papillæ of the kidney are received.

Canaliculus (Lat. dim. of *canalis*, a canal). The minute canals in bone, and the passages to carry away the tears are so called.

Cancelli (Lat. *cancelli*, lattices). The spongy structure of bone.

Canine (Lat. *canis*, a dog). The canine teeth are very largely developed in the dog tribe.

Capillaries (Lat. *capillus*, a hair). The minute blood-vessels traversing the tissues.

Capsule (Lat. *capsula*, a little box). The membrane enclosing an organ.

Cardiac (Gk. καρδια, the heart). Belonging to the heart.

Carotid (Gk. καρόω, I induce sleep). Pressure on the carotid arteries produces sleep.

Carpus (Gk. καρπός, the wrist). The bones of the wrist.

Caruncula (Lat. dim. of *caro*, flesh). A little fleshy prominence.

Cauda equina (Lat., a horse's tail). The nerves given off from the lower end of the spinal cord.

Cavernous (Lat. *cavus*, hollow).

Cementum (Lat. *cementum*, a rough stone). The substance covering the fang of a tooth.

Cephalic (Gk. κεφαλή, the head). Belonging to the head.

Cerebellum (dim. of *cerebrum*). The lesser brain.

Cerebrum (Lat., the brain). The greater brain.

Cervix (Lat. *cervix*, the neck). **Cervical**, belonging to the neck.

Choroid (Gk. χοριον, the chorion, and εἶδος, like). The vascular coat of the eye.

Chyle (Gk. χῦλος, juice). The fluid resulting from digestion, and absorbed by the lymphatics of the small intestine.

Ciliary (Lat. *cilium*, an eyelash). Belonging to the eye or its appendages.

Circumduction (Lat. *circum*, around, and *duco*, I lead). The motion of a limb in describing a circle.

Circumvallate (Lat. *circumvallatus*, trenched around).

Clavicle (Lat. *clavis*, a key). The collar-bone.

Clitoris (Gk. κλείω, I enclose). The female organ corresponding to the penis in the male.

Coccyx (Gk. κόκκυξ, a cuckoo). The tail-bone.

Cochlea (Gk. κόχλος, a spiral shell). Part of the internal ear.

Cœliac (Gk. κοίλια, the belly). Belonging to the belly.

Colon (Gk. κῶλον, the colon). The large intestine.

Condyle (Gk. κόνδυλος, a knuckle).

Conjunctiva (Lat. *conjungo*, I join). The mucous membrane of the eyelids and eyeball.

Constrictor (Lat. *constringere*, to bind tightly together).

Coracoid (Gk. κόραξ, a raven, and εἶδος, like). A process of the scapula.

Corium (Gk. χόριον, leather). The deep layer of the skin.

Cornea (Lat. *corneus*, horny). The clear anterior part of the eye.

Cornua (Lat. *cornu*, a horn). Processes which project like horns.

Corpus (Lat., a body). Examples: Corpus callosum (Lat. *callus*, hard); Corpus cavernosum (Lat. *caverna*, a cavern); Corpus spongiosum (Lat. *spongia*, a sponge); Corpus striatum (Lat. *stria*, a streak).

Corpuscle (Lat. *corpusculum*, a little body).

Corrugator (Lat. *corrugare*, to wrinkle).

Cortex (Lat. *cortex*, a rind). The outer layers of an organ.

Costal (Lat. *costa*, a rib). Belonging to the ribs.

Cotyloid (Gk. κοτύλη, a cup, and εἶδος, like). The acetabulum is called also the cotyloid cavity.

Cranium (Gk. κρανιον, the skull).

Cremaster (Gk. κρεμάω, I suspend). The suspensory muscle of the testicle.

Cribriform (Lat. *cribrum*, a sieve, and *forma*, like). Sieve-like.

Cricoid (Gk. κρίκος, a ring, and εἶδος, like). The name of one of the cartilages of the larynx.

Crus (Lat. *crus*, a leg). From the same root we have *crural* and *crureus.*

Cuboid (Gk. κὺβος, a cube, and εἶδος, like). Cube-shaped.

Cuticle (Lat. *cuticula*, dim. of *cutis*, the skin). The surface layer of the skin.

Cystic (Gk. κύστις, a bladder or bag). Belonging to the urinary or gall bladder.

Deglutition (Lat. *deglutire*, to swallow). The act of swallowing.

Deltoid. Like the Greek letter Delta (Δ).

Dentine (Lat. *dens*, a tooth). The tissue forming the greater part of a tooth.

Derma (Gk. δέρμα, the skin). The deep layer of the skin.

Diaphragm (Gk. διαφραγμα, a partition). The midriff, or muscular septum between the abdomen and thorax.

Diarthrosis (Gk. δία, through, and ἄρθρόν, a joint). A movable joint.

Digastric (Gk. δίς, twice, and γαστήρ, a belly). Two-bellied.

Diploë (Gk. διπλους, double).

Duodenum (Lat. *duodeni*, twelve). The first part of the small intestine.

Dura mater (Lat. *dura*, hard, and *mater*, mother). The outer membrane of the brain.

Enamel (Gk. ἐν, in, and Fr. *émail*). The substance forming the crowns of the teeth.

Enarthrosis (Gk. ἐν, in, ἄρθρόν, a joint). A ball-and-socket joint.

Endocardium (Gk. ἔνδον, within, and καρδια, the heart). The membrane lining the interior of the heart.

Endothelium (Gk. ἔνδον, within, and θηλὴ, papilla). The cells lining the serous cavities and blood-vessels.

Ensiform (Lat. *ensis*, a sword, and *forma*, shape).

Epidermis (Gk. ἐπὶ, upon, and δέρμα, the skin). The scarf-skin.

Epididymis (Gk. ἐπὶ, upon, and δίδυμος, the testicle).

Epigastrium (Gk. ἐπὶ, upon, and γαστήρ, stomach). The upper of the three middle regions of the abdomen.

Epiglottis (Gk. ἐπὶ, upon, and γλῶττις, the glottis). The little lid which covers the entrance to the air passages during swallowing.

Epiphysis (Gk. ἐπὶ, upon, and φύω, I grow). The ends of long bones formed by separate centres from those of the shafts.

Epithelium (Gk. *ἐπὶ*, upon, and *θηλή*, papilla). The layers of cells on the surface of skin and mucous membrane.

Erector (Lat. *erigere*, to raise).

Ethmoid (Gk. *ἠθμος*, a sieve, and *εἶδος*, like). One of the bones of the skull.

Extensor (Lat. *extendere*, to stretch around).

Fallopian tubes. The oviducts; so named from Fallopius, the anatomist who first described them.

Fascia (Lat. *fascia*, a bundle). A sheet formed of fibrous tissue.

Fauces (Lat. plural of *faux*, the throat). The opening between the mouth and throat.

Femur (Lat. *femur*, the thigh). The thigh-bone.

Fibula (Lat. *fibula*, a clasp). The small bone of the leg.

Fimbriæ (Lat. *fimbriæ*, fringes). The fringes of the Fallopian tube.

Flexor (Lat. *flectere*, to bend).

Follicle (Lat. dim. of *follis*, a bag). Little sacs with open mouths.

Foramen (Lat. *foramen*, a hole).

Fornix (Lat. *fornix*, an arch or vault). An arched commissure of the brain.

Fourchette (Fr. *fourchette*, a fork). A fold of mucous membrane connecting the two labia majora posteriorly.

Fundus (Lat. *fundus*, the bottom). The base of an organ.

Fungiform (Lat. *fungus*, and *forma*, shape).

Galactophorous (Gk. *γάλα*, milk, and *φορέω*, I carry). The milk ducts.

Ganglion (Gk. *γάγγλιον*, a tumour or enlargement). A nerve-centre.

Gastric (Gk. *γαστήρ*, the belly). Connected with the stomach.

Gastrocnemius (Gk. *γαστήρ*, the belly, and *κνήμη*, the leg). The muscle forming the calf or bellied part of the leg.

Gemellus (Lat. dim. of *geminus*, double). Twin muscles.

Ginglymus (Gk. *γίγγλυμος*, a hinge). A hinge-joint.

Glans (Lat. *glans*, an acorn). The extremity of the penis or clitoris.

Glenoid (Gk. *γλήνη*, a socket, and *εἶδος*, like). The socket for the condyle of lower jaw, and that for the head of the humerus, are so named.

Glomerulus (Lat. dim. of *glomus*, a ball of thread). The vascular tufts of the kidney.

Glosso- (Gk. *γλῶσσα*, the tongue). This prefix indicates that the structure named is connected with the tongue.

Glottis (Gk. *γλῶττις*). The opening of the larynx.

Gluteus (Gk. *γλουτός*, the buttock). Muscles of the buttock have this name.

Gomphosis (Gk. γόμφος, a nail). A nail-like articulation.

Gustatory (Lat. *gusto*, I taste). Connected with taste.

Hæmorrhoidal (Gk. αἷμα, blood, and ῥέω, I flow). Term applied to those vessels which bleed in piles.

Haversian. Canals in bone are called Haversian because first described by an anatomist named Havers.

Hepatic (Gk. ἡπατικός, of the liver). Belonging to the liver.

Hilus (Lat. *hio*, I open). A groove or fissure in an organ.

Histology (Gk. ἱστος, a web, and λογος, a treatise). The study of the minute structure of tissues.

Hyaline (Gk. ὕαλος, glass). Translucent and apparently structureless.

Hyoid (Gk. υ, upsilon, and εἶδος, like). The bone of the tongue.

Hypochondrium (Gk. ὑπό, under, and χόνδρος, cartilage). The region of the abdomen situated under the cartilages of the lower ribs.

Hypogastric (Gk. ὑπὸ, under, and γαστήρ, the stomach). The region at the lower part of the belly.

Hypoglossal (Gk. ὑπὸ, under, and γλῶσσα, the tongue). Beneath the tongue.

Ileum (Gk. εἰλέω, I roll up). The lower three-fifths of the small intestine.

Iliac (Lat. *ilia*, the flanks). Belonging to the flanks.

Infraorbital (Lat. *infra*, beneath, and *orbs*, a circle). Beneath the orbit.

Inguinal (Lat. *inguen*, the groin). Belonging to the groin.

Inosculation (Lat. *in*, in, and *osculum*, a little mouth). The communication of vessels.

Integument (Lat. *in*, in, and *tego*, I cover). The skin.

Iris (Gk. ἴρις, the rainbow). The coloured part of the eye.

Ischium (Gk. ἰσχὶον, the hip). The hip-bone. *Ischiatic.*

Jejunum (Lat. *jejunus*, empty). The upper two-fifths of the small intestine.

Jugular (Lat. *jugulum*, the throat). Veins of the throat.

Labia (Lat. pl. of *labium*, a lip). Lips.

Labyrinth (Gk. λαβύρινθος, a maze). The internal ear.

Lachrymal (Lat. *lachryma*, a tear). Pertaining to the tears.

Lacunæ (Lat. dim. of *lacus*, a lake). Small cavities in bone.

Lambdoidal (Gk. Λ, lambda, and εἶδος, like).

Larynx (Gk. λάρυγξ, the larynx). The voice-box.

Levator (Lat. *levare*, to lift up). A muscle which raises any part.

Ligament (Lat. *ligare*, to bind).

Linea aspera (Lat. *linea*, a line, and *asper*, rough)

Lingual (Lat. *lingua*, the tongue). Belonging to the tongue.

Lumbricales (Lat. *lumbricus*, an earth-worm). Little muscles connecting the flexor and extensor tendons of the fingers.

Lymph (Lat. *lympha*, water). The clear fluid contained in the lymphatic vessels. Hence *lymphatic*.

Malar (Lat. *mala*, the cheek). The cheek-bone.

Malleolar (Lat. *malleolus*, dim. of *malleus*, a hammer). Belonging to the projections of bone at the ankle.

Malleus (Lat. *malleus*, a hammer). One of the bones of the middle ear.

Masseter (Gk. μασσάομαι, I chew). One of the muscles of mastication.

Mastoid (Gk. μαστος, a breast, and εἶδος, like). A prominence resembling the nipple.

Maxillary (Lat. *maxilla*, the cheek-bone). Belonging to the jaws.

Meatus (Lat. *meatus*, a passage).

Medulla (Lat. *medius*, middle). Marrow.

Meninges (Gk. μήνιγξ, a membrane). The membranes of the brain.

Mental (Lat. *mentum*, the chin). Belonging to the chin.

Mesentery (Gk. μέσος, middle, and ἔντερον, the intestine). The fold of peritoneum which attaches the small bowel to the posterior abdominal wall.

Meta- (Gk. μετά, beyond). Used in *metatarsus*, *metacarpus*.

Molar (Lat. *mola*, a millstone). Grinding teeth.

Mons Veneris (Lat. mountain of Venus). The pad of fat, &c., over the pubes of the female.

Mylo-hyoid (Gk. μύλη, a millstone). A muscle attached to the lower jaw (part of the mill) and the hyoid bone.

Myoides (Gk. μῦς, a muscle, and εἶδος, like). Used in *platysma myoides*.

Nares (Lat. *nares*, the nostrils). The apertures of the nose.

Nasal (Lat. *nasus*, the nose). Belonging to the nose.

Navel (Sax. *nafela*, from *nafa*, the nave of a wheel).

Navicular (Lat. *navicula*, a small ship). Equivalent to scaphoid.

Neurolemma (Gk. νεῦρον, a nerve, and λέμμα, a skin). The primitive sheath of nerve fibre.

Nucleus (Lat. *nucleus*, a kernel). The central spot in a cell.

Nymphæ (Νυμφαι, nymphs). The lesser folds bordering the genital fissure.

Obturator (Lat. *obturo*, I stop up). An opening in the innominate bone, nearly closed by membrane.

Occiput (Lat. *ob*, *caput*, at the back of the head).

Odontoid (Gk. ὀδοὺς, a tooth, and εἶδος, like). The tooth-like process of the axis.

Œsophagus (Gk. *οἴω*, *οἴσω*, I carry, and *φάγειν*, to eat). The gullet.

Olecranon (Gk. *ὠλένη*, the elbow, *κρᾶνον*, the head). The tip of the elbow.

Olfactory (Lat. *olfacere*, to smell). Belonging to the sense of smell.

Omentum (Lat. *omentum*, the caul, wherein the bowels are wrapped).

Ophthalmic (Gk. *ὀφθαλμός*, the eye). Belonging to the eye.

Optic (Gk. *οπτομαι*, to see). Belonging to sight.

Orbicular (Lat. *orbiculus*, a little orb). Forming a sphere or a ring.

Os (gen. *oris*). The mouth.

Os (gen. *ossis*). A bone.

Os calcis (Lat. *os*, a bone, and *calx*, the heel). The heel-bone.

Osteoblasts (Gk. *ὀστέον*, bone, and *βλαστός*, a germ). The formative cells of bone.

Osteoclasts (Gk. *ὀστέον*, bone, and *κλάω*, I break). The destructive cells of bone.

Osteology (Gk. *ὀστέον*, a bone, and *λόγος*, a treatise). The study of bones.

Ovarian (Lat. *ovum*, an egg). Belonging to the ovary.

Ovum (Lat. *ovum*, an egg).

Pancreas (Gk. *πᾶν*, all, and *κρέας*, flesh). The sweet-bread.

Papillæ (Lat. *papillæ*, teats). The small conical eminences on the tongue, and in the deep layer of the skin.

Parietal (Lat. *paries*, a wall). Lateral bones of the vault of the skull.

Parotid (Gk. *παρα*, beside, and *οὖς*, the ear). The salivary gland placed between the ear and the lower jaw.

Patella (Lat. *patella*, a small pan). The knee-pan.

Pectineal (Lat. *pecten*, the pubic bone). A line on the pubic bone.

Pectoralis (Lat. *pectus*, the breast). Two pairs of muscles on the front wall of the chest are so named.

Pelvis (Lat. *pelvis*, a basin). The bony girdle containing the bladder and internal organs of generation.

Penis (Lat. *penis*, a tail). The male organ of generation.

Pericardium (Gk. *περί*, around, and *καρδία*, the heart). The bag which contains the heart.

Perineum (Gk. *περί*, around, and *ναίω*, I am situated). The space between anus and scrotum, or anus and vagina.

Periosteum (Gk. *περί*, around, and *ὀστεον*, a bone). The membrane covering a bone.

Peritoneum (Gk. *περί*, around, and *τείνω*, I stretch). The lining membrane of the abdominal and pelvic cavities.

Peroneal (Gk. *περόνη*, the pin of a brooch). Connected with the fibula.

Petrous (Gk. *πέτρα*, a rock). Part of the temporal bone.

Peyer's patches. Groups of lymphoid nodules in the small intestine.

Phalanx (Gk. φάλαγξ, a rank of soldiers). A bone of a finger or toe.

Pharynx (Gk. φαρυνξ, the throat). The food-bag.

Phrenic (Gk. φρήν, the mind). Connected with the diaphragm.

Pia mater (Lat. *pia*, tender, and *mater*, mother). The inner membrane of the brain.

Pisiform (Lat. *pisum*, a pea). The smallest of the wrist-bones.

Pleura (Gk. πλευρά, the side). The membrane lining the chest.

Pneumogastric (Gk. πνεύμων, the lung, and γαστήρ, the stomach). The vagus nerve distributed to the lungs and stomach.

Pomum Adami—"Adam's Apple". The prominence of the thyroid cartilage of the larynx.

Popliteal (Lat. *poples*, the ham). The space at the back of the knee.

Portal (Lat. *porta*, a gate). The vein carrying blood to the liver.

Portio dura (Lat. *portio*, a part, and *dura*, hard). The facial nerve.

Prepuce (Lat. *preputium*, the fore-skin).

Pronator (Lat. *pronus*, face downwards).

Prostate (Gk. πρό, in front of, and ἵστημι, I stand). A glandular body placed in front of the male bladder.

Protoplasm (Gk. πρῶτος, first, and πλάσσω, I form). The material of which all active cells are composed.

Psoas (Gk. ψόα, the loin). A muscle of the loin.

Pterygoid (Gk. πτερυξ, a wing, and εἶδος, like). Wing-like process.

Pubes (Lat. *pubescens*, covered with hair).

Pudic (Lat. *pudeo*, I am ashamed).

Pulmonary (Lat. *pulmo*, the lung). Belonging to the lung.

Pylorus (Gk. πυλωρός, a gatekeeper). The lower opening of the stomach.

Quadriceps (Lat.) Having four heads.

Racemose (Lat. *racemus*, a cluster of grapes). Clustered.

Radius (Lat. *radius*, the spoke of a wheel). The outer bone of the fore-arm.

Ramus (Lat. *ramus*, a branch).

Raphé (Gk. ῥαφή, a seam). The line of junction of two lateral parts.

Rectus, Rectum (Lat. *rectus*, straight). A straight muscle or tube.

Renal (Lat. *ren*, the kidney). Belonging to the kidney.

Retina (Lat. *rete*, a net). The nervous layer of the eye.

Risorius (Lat. *rideo*, I laugh).

Rugæ (Lat. *ruga*, a wrinkle). Folds of mucous membrane.

Sacculus (Lat. dim. of *saccus*, a bag). A membranous bag in the internal ear.

Sacrum (Lat. *sacris*, sacred).

Saphena (Gk. σαφηνής, manifest). A large vein of the leg.

Sarcolemma (Gk. σαρξ, flesh, and λέμμα, a covering). The thin membrane enclosing the fibre of striped muscle.

Sartorius (Lat. *sartor*, a tailor). A muscle used in crossing the legs.

Scala (Lat. *scala*, a stair). Name given to the passages in the cochlea of the internal ear.

Scalenus (Gk. σκαληνός, a figure having three unequal sides).

Scaphoid (Gk. σκαφή, a boat, and εἶδος, like). Boat-shaped.

Scapula (Gk. σκαπάνη, a spade). The shoulder-blade.

Sciatic. See *Ischium*.

Sclerotic (Gk. σκλερός, hard). The dense outer coat of the eye.

Scrotum (Lat. *scrotum*, a leather bag). The bag containing the testicles.

Sebaceous (Lat. *sebum*, suet). The glands which lubricate the hairs are thus named.

Septum (Lat. *sepio*, I hedge in). A partition.

Serratus (Lat. *serra*, a saw). Name given to a muscle of the chest wall, because the slips of it resemble the teeth of a saw.

Sesamoid (Gk. σησάμον, sesame, and εἶδος, like). Bones contained in the tendons of muscles.

Sinus (Lat. *sinus*, a hollow). Name given to the large veins in the cranium, and also to air cavities in the bones of the skull.

Skeleton (Gk. σκέλλω, I dry). The dry bones.

Soleus (Lat. *solea*, a sandal). A flat muscle of the calf.

Spermatozoa (Gk. σπέρμα, a seed, and ζῶον, an animal). The generative cells of the male.

Sphenoid (Gk. σφήν, a wedge, and εἶδος, like). One of the bones of the skull.

Sphincter (Gk. σφιγγω, I contract). Term applied to a muscle closing an aperture.

Spleen (Gk. σπλήν, the spleen).

Squamous (Lat. *squama*, a scale). A thin, scale-like portion of bone.

Sternum (Gk. στερνον, the breast or chest). The breast-bone.

Styloid (Gk. στῦλος, a style or pen, and εἶδος, like). A style-like process.

Sublimis (Lat. *sublimis*, superficial).

Sudoriferous (Lat. *sudor*, sweat, and *fero*, I bear). Sweat glands and ducts.

Supinator (Lat. *supinus*, lying face upwards). A muscle which, by acting on the forearm, causes the palm of the hand to be directed upwards.

Suture (Lat. *sutura*, a seam). The union of the bones of the skull.

Symphysis (Gk. σύν, together, and φύω, I grow). A joint in which there is little or no movement.

Synarthrosis (Gk. σύν, together, and ἄρθρόν, a joint). A joint in which there is no movement.

Synchrondrosis (Gk. σύν, together, and χόνδρος, cartilage). Union by means of cartilage.

Tarsus (Gk. ταρσός, the upper surface of the foot). The bones of the back part of the foot.

Temporal (Lat. *tempora*, the temples, from *tempus*, time). Belonging to the temples.

Tendon (Lat. *tendere*, to stretch). The fibrous band by which a muscle is attached to a bone.

Tensor (Lat. *tendere*, to stretch). A muscle which puts a structure on the stretch.

Teres (Lat. *teres*, round).

Thalamus (Gk. θάλαμος, a bed).

Theca (Gk. θήκη, a case). A sheath for the finger tendons.

Thorax (Gk. θώραξ, a breast-plate). The chest.

Thymus (Lat. *thymus*, thyme). A gland-like body found in the lower part of the neck of young animals.

Thyroid (Gk. θυρεός, a shield, and εἶδος, like). Shield-shaped.

Tibia (Lat. *tibia*, a pipe or flute).

Trabeculæ (Lat. dim. of *trabs*, a beam). Fibrous bands in the spleen and other organs.

Trachea (Gk. τραχύς, rough). The wind-pipe.

Trapezium, Trapezius (Gk. τράπεζα, a table). Having a tabular form.

Triceps (Lat. *tres*, three, and *caput*, a head). Having three heads.

Tricuspid (Lat. *tres*, three, and *cuspis*, a point.) Having three points.

Trigone (Gk. τρεῖς, three, and γωνία, an angle). A triangle at the base of the bladder.

Trochanter (Gk. τροχάω, I roll or turn).

Trochlea (Gk. τροχός, a wheel). A kind of pulley.

Turbinated (Lat. *turbo*, a top). Coiled bones in the nose.

Ulna (Gk. ὠλένη, the elbow). The inner bone of the forearm.

Umbilicus (Lat. *umbilicus*). The navel.

Ureter (Gk. οὐρέω, I pass water). The tube conveying the urine from the kidney to the bladder.

Urethra (Gk. οὖρον, urine). The canal conveying the urine from the bladder.

Uterus (Lat. *uterus*, the womb).

Uvula (Lat. dim. of *uva*, a grape). The small tongue hanging from the middle of the soft palate.

Vagina (Lat. *vagina*, a sheath). The vulvo-uterine canal.

Vagus (Lat. *vago*, I wander). The pneumogastric nerve.

Vermiform (Lat. *vermis*, a worm, and *forma*, shape). Worm-shaped.

Vertebræ (Lat. *vertere*, to turn). The bones forming the spinal column.

Vesical (Lat. *vesica*, a bladder). Belonging to the bladder.

Villi (Lat. *villus*, shaggy hair). Small processes on the mucous membrane of the small bowel.

Viscera (pl. of Lat. *viscus*, an internal organ). The internal organs.

Vitreous (Lat. *vitrum*, glass). The transparent mass occupying the back part of the eye.

Vomer (Lat. *vomer*, a ploughshare). The central bone of the nose.

Vulva (Lat. *volvere*, to roll). The genital opening of the female.

Xiphoid (Gk. *ξίφος*, a sword, and *εἶδος*, like). The lower piece of the sternum.

Zygoma (Gk. *ζεύγνυμαι*, I yoke or join together). The process which joins together the bones of the head and face.

DESCRIPTION OF THE PLATES.

THE SKELETON (Fig. 1).

1. Frontal bone.
2. Parietal bone.
3. Temporal bone.
4. Coronal suture.
5. Malar or cheek-bone.
6. Nasal bones.
7. Superior maxillary—Upper jaw-bone.
8. Orbits.
9. Side of occipital bone.
10. Condyle of lower jaw.
11. Angle of lower jaw.
12. Symphysis of lower jaw.
13. Four lower cervical vertebræ.
14. Two upper and two lower dorsal vertebræ.
15. Lumbar vertebræ.
16. Sacrum.
17. Coccyx.
18. Cartilages of ribs.
19. Ribs.
20. First bone of sternum } Breast-
21. Second bone of sternum } bone.
22. Ensiform cartilage.
23. Clavicles—Collar-bones.
24. Coracoid process of scapula—Shoulder-blade.
25. Acromion of scapula.
26. Anterior surface of scapula.
27. Head of humerus—Arm-bone.
28. Shaft of humerus.
29. Condyles of humerus.
30. Head of radius.
31. Shaft of radius.
32. Ulna.
33. Carpal ends of radius and ulna.
34. Ilium.
35. Anterior superior spine of ilium.
36. Anterior inferior spine of ilium.
37. Symphysis pubis.
38. Tuberosity of ischium.
39. Brim of pelvis.
40. Obturator foramen.
41. Head of femur or thigh-bone.
42. Neck of femur.
43. Great trochanter.
44. Shaft of femur.
45. Condyles of femur.
46. Patella—Knee-pan.
47. Head of tibia.
48. Shaft of tibia.
49. Lower end of tibia.
50. Fibula.

FRONT VIEW OF RIGHT HAND AND WRIST (Fig. 2).

1. Scaphoid.
2. Semilunar.
3. Cuneiform.
4. Pisiform.
5. Trapezium.
6. Trapezoid.
7. Os magnum.
8. Unciform.
9. Metacarpal bones of thumb and fingers.
10. First row of phalanges of thumb and fingers.
11. Second row of phalanges of fingers.
12. Terminal phalanges of thumb and fingers.

FRONT VIEW OF RIGHT FOOT (Fig. 3).

1. Superior articulating surface of astragalus.
2. Anterior portion of astragalus.
3. Os calcis—Heel-bone.
4. Commencement of groove of interosseous ligament.
5. Scaphoid.
6. Tuberosity of scaphoid.
7. Internal cuneiform.
8. Middle cuneiform.
9. External cuneiform.
10. Cuboid.
11. Metatarsal bones.
12. First row of phalanges of toes.
13. Second row of phalanges.
14. Terminal phalanges.

THE MUSCLES.

SIDE VIEW OF FULL FIGURE (Fig. 1).

1. Occipito-frontalis.
2. Temporal.
3. Orbicularis palpebrarum
4. Masseter.
5. Sterno-mastoid.
6. Trapezius.
7. Platysma myoides.
8. Deltoid.
9. Biceps.
10. Brachialis anticus.
11. Triceps.
12. Supinator longus.
13. Extensor muscles of thumb.
14. Extensor muscles of wrist.
15. Pectoralis major.
16. Latissimus dorsi.
17. Serratus magnus.
18. Obliquus externus abdominis.
19. Rectus abdominis in its sheath.
20. Gluteus medius.
21. Gluteus maximus.
22. Tensor vaginæ femoris.
23. Vastus externus.
24. Biceps.
25. Gastrocnemius.
26. Tibialis anticus.
27. Extensor communis digitorum.
28. Soleus.
29. Peroneus longus.
30. Peroneus brevis.
31. Peroneus tertius.
32. Abductor minimi digiti.
33. Extensor hallucis.
34. Flexor communis digitorum.
35. Tendo Achillis.

FRONT VIEW OF RIGHT ARM (Fig. 2).

1. Deltoid.
2. Pectoralis major.
3. Coraco brachialis.
4. Biceps.
5. Brachialis anticus.
6. Triceps.
7. Pronator radii teres.
8. Supinator longus.
9. Flexor carpi radialis.
10. Palmaris longus, and palmar fascia.
11. Flexor digitorum communis.
12. Flexor carpi ulnaris.
13. Abductor pollicis.
14. Flexor brevis pollicis.
15. Palmaris brevis.

FRONT VIEW OF RIGHT LEG (Fig. 3).

1. Gluteus medius.
2. Tensor vaginæ femoris.
3. Psoas and iliacus.
4. Pectineus.
5. Adductor longus.
6. Sartorius.
7. Gracilis.
8. Rectus femoris.
9. Vastus externus.
10. Vastus internus.
11. Biceps flexor cruris.
12. Insertion of ligament of patella into tibia.
13. Tibialis anticus.
14. Extensor communis digitorum.
15. Peroneus longus.
16. Gastrocnemius.
17. Soleus.
18. Peroneus brevis.
19. Abductor hallucis.

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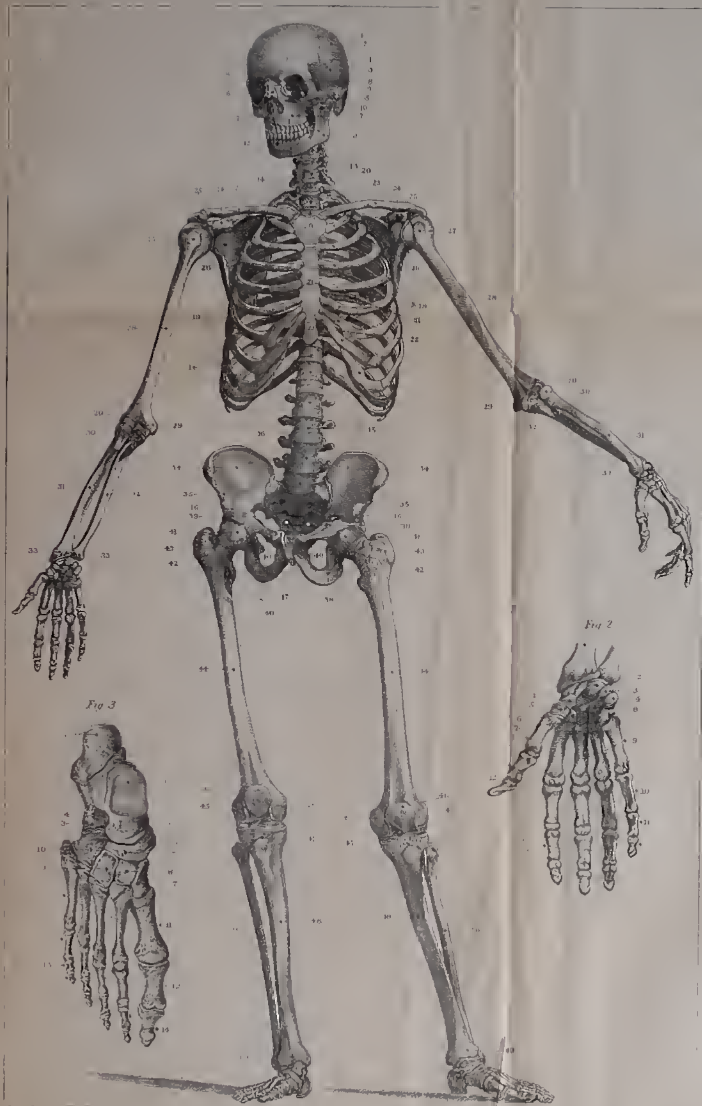
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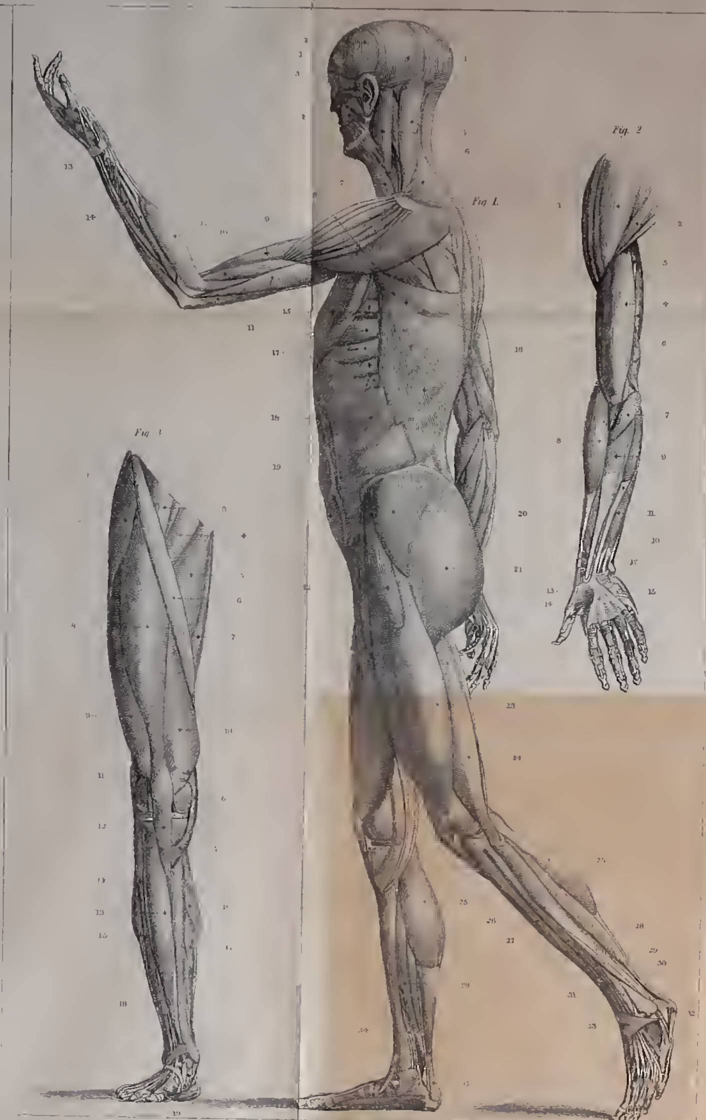
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